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The ferns and flowering plants of Nantucket—XII

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CACTACEAE

OPUNTIA.

In the history of Nantucket botany this cactus bears the distinction of having been the first one of the island's plants to receive formal botanical mention and published record. We do not know that it was ever seen on Nantucket by civilized man prior to its discovery there by Mr. Thomas A. Green, of New Bedford, on whose authority it was announced as a Nantucket plant as long ago as 1833 by Professor Edward Hitchcock in his "Report on the Geology, Mineralogy, Botany and Zoology of Massachusetts." Other plants of Nantucket find record in the same work but the prickly pear, under the name *Cactus Opuntia* L., has priority of place, thus, eighty years ago, marking the starting point of exact Nantucket botany.

On Nantucket this cactus is at the extreme northeastern limit of its range and is native only on that long arm of sand known as Coatue, which reaches along the western side of the harbor protecting it from Nantucket Sound. It abounds there in sandy openings among the low red cedars taking so strong a growth as to form close assurgent clusters sometimes three to five feet across.

Only once have I seen it there when it was in full bloom, on July 13, 1912. Its flowers were in great profusion, and one plant of three and a half feet spread bore about 220 blossoms. The flowers are bright yellow with a conspicuous red center and are

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6.3–7.5 cm. across, pressing out to as much as 9.5 cm.; petals 8–12, mucronate, 2.5–3.2 cm. wide; cluster of stamens 3.8–4.5 cm. in natural spread. The red center of the flower is patterned as a star, its rays tapering out beyond the stamens along the midveins of the petals. Larger stems, 10.5 dm. long, may bear as many as thirty joints, these narrowly oblong to obovate, becoming 18 cm. long and 8 cm. wide, occasionally narrow and trigonous. Fruits often seven, sometimes nine, on one joint, marginal or one or more also lateral, mostly 3.75–4 cm. long, commonly narrowed from apex to base, when lateral sometimes 5.5 cm. long. Base of the plant bulbous, becoming woody and much enlarged; main root horizontal and greatly elongated; a root carefully excavated Sept. 7, 1904 was nine and a half feet in length.

Two species of cactus have been attributed to Nantucket doubtless with reference to the spiny and spineless plants found on Coatue. These are not to be regarded as other than forms or varieties of one species. They do indeed stand well apart in the one character of armature, and it is probably true that some plants always produce spines and that others never do. But the flowers of each are essentially the same, although a close comparison, made on the one occasion when the plants were found in bloom, makes it possible to say that those of the spiny form were quite generally a trifle the smaller with slightly narrower petals, and usually a little more color—the red a shade deeper and the yellow just perceptibly brighter. A very small proportion of the unarmed form bear a few spines, sometimes not more than one or two and only on a single one of the joints.

I have not used any specific name for this cactus believing that two distinct species of *Opuntia* belong to our eastern flora and that it will therefore need to be determined to which one the current names *Opuntia vulgaris* Mill. and *Opuntia Opuntia* (L.) Coult. properly belong. Among the rocky hills on Manhattan Island and beyond, near Van Cortlandt Park, and in Bronx Park, there grows a cactus which is to me not at all the same species as the sand inhabiting littoral plant found on Nantucket. It thrives on rocky knolls in hilly woodland, either quite exposed to the sun or in partial shade, and has smaller flowers, which are light yellow throughout with never the faintest tinge of red, as I

have observed it. It is a smaller plant than the Nantucket species with shorter and more rounded joints of a duller green color and I have never seen on it even the rudiment of a spine nor observed that it ever developed a bulbous woody base or greatly elongated roots. It is also of more prostrate habit than the Nantucket plant.

LYTHRACEAE

DECODON VERTICILLATUS (L.) Ell.

No aquatic plant of Nantucket grows up in a greater number of ponds and bog holes than the swamp loosestrife and where it gets a footing it slowly pushes into undisputed possession of the places it chooses to occupy. It is the only shrubby aquatic of the island's ponds, where it makes the outermost fringe of vegetation along many a bushy shore, its wandlike arching and recurving stems forming an airy embankment above the water. In the autumn its foliage becomes as brilliant as it is possible for leaves to be and encircles some of the smaller ponds with a zone of variegated scarlet. The Pout Ponds deep set among the hills make a memorable scene when thus emblazoned.

On Nantucket this plant seems to be always more or less pubescent, the upper part of the stem and the leaves beneath even densely tomentulose with branched or substellate often ferruginous hairs.

New shoots a few inches high May 30, 1909, and just noticeable June 3, 1911; in full flower Aug. 15, 1906.

LYTHRUM SALICARIA L.

Mrs. Owen's catalogue records "a few plants in danger of extinction near Long Pond." Today, twenty-five years later, a few plants are still to be found there. They grow close to the shore at the "Gut," where I first saw them Aug. 12, 1906, then passing out of bloom. It was in full flower July 10, 1912, and beautifully conspicuous from the bright rose-purple spikes borne by three separated groups of plants. On June 1, 1909, the tallest plants were about six inches high.

The Nantucket plant is the form having the upper stem and the leaves with the bracts and calyx densely white tomentulose—var. *tomentosum* (Mill.) DC.

MELASTOMACEAE

RHEXIA VIRGINICA L.

Common in sandy swamps and along pond shores. In fresh flower Aug. 12, 1906; continues to bloom into September. The leaves show considerable variation in form, from lanceolate-oblong and acute, to ovate or, on small plants, even quite orbicular.

ONAGRACEAE

ISNARDIA PALUSTRIS L.

Very common in muddy pond holes and ditches.

* LUDWIGIA ALTERNIFOLIA L.

Another one-locality plant of Nantucket, It was found Aug. 29, 1904, well established about one of the small ponds at Shimmo Valley farm, bearing abundant fruit and some late flowers.

* CHAMAENERION ANGUSTIFOLIUM (L.) Scop.

This tall herb, so conspicuous when in bloom from midsummer till autumn, is not included in Mrs. Owen's catalogue of 1888 although it had become frequent not many years later. It seems to have been first collected as far back as 1886 by Mrs. Cornelia L'Hommédieu near the Agricultural Grounds. Two years later it was found by Mrs. Owen in Polpis, and again, in 1892, by Mrs. Mabel P. Robinson. There is no record that it was anywhere common before 1895, when Mr. Dame reported it as abundant at Gibbs Swamp "appearing after an extensive brush fire," and Mr. Floyd found it well established on the "commons." For these records I am indebted to Mr. Floyd's manuscript notes. Today the plant is rather common, even locally abundant, on the eastern side of the island from Polpis and about Sauls Hills to Tom Nevers Swamp, and along the railroad in the southeast quarter. It does not yet appear to have spread into Shawkemo, Quaise, Pocomo or Squam. Further west it occurs at a few stations in the South Pasture, in Taupawshas Swamp, and near the state road not far beyond the town. On the western side of the island I have met with it near Miacomet Pond (1899), the "Woods" (1904), and Trots Swamp (1912). First flowers July 3, 1912; it sometimes continues to bloom until late in September.

A single plant with white flowers was found in Gibbs Swamp by Mr. Dame in 1895 (F. G. Floyd).

EPILOBIUM HIRSUTUM L.

Common in the lower parts of the town and out into the suburbs, often massed along ditches and in the corners of damp lots and low fields; also by the roadside in Shawkemo, the only place where I saw it far out from the town. Mr. Floyd reports that it was found by Mr. Dame in 1895 well established at Gibbs Swamp, where it was very common the following year coming in with the preceding species after an extensive brush fire. According to Mrs. Owen its introduction on the island was in or about the year 1855, when it was raised in a garden in Union Street, subsequently spreading into waste places.

First flowers July 6, 1912; blooming through September.

On the uninhabited southern extremity of Chappaquiddick Island, Marthas Vineyard, a single plant, still in flower, was found Sept. 28, 1912, growing with an abundance of *Chemaenerion angustifolium* in a grove of pines which had been swept by fire early in the same year.

* EPILOBIUM PALUSTRE L.

Rare and local; sphagnum bogs in Squam and west of Sankaty and near Reed Pond, also Tom Nevers Swamp. It appears to flower earlier than *Epilobium lineare;* mature fruit Aug. 13, 1908. Still some flowers Sept. 11, 1907. Collected at one station on Marthas Vineyard. This is the slender little bog plant that has been called var. *monticola* Haussk. Its variations are considerable, however, and take it into forms that are close to typical *palustre* as well as into others that nearly match specimens of var. *labradoricum* Haussk. It is from 1–2 dm. high, erect, often with decumbent base and sometimes stoloniferous, simple with a single terminal flower or well branched, the glabrate leaves numerous and closely ascending or more distant and spreading, sessile or petiolulate, 1–3 cm. long, 1–4 mm. wide, linear-lanceolate to oblanceolate or oval-oblong, either tapering or contracted to the rounded apex, thickish or rather thin; pedicels very slender, mostly elongated, sometimes longer than the pod, again only one quarter its length.

EPILOBIUM LINEARE Muhl.

Common in bogs. Plants six inches high June 27, 1912; first flowers Aug. 14, 1906; continues to bloom through September.

* EPILOBIUM STRICTUM Muhl.

Rare and local in bogs and wet mossy places in open ground. Watts Run bog, Shawaukemmo meadow, shore of Sachacha Pond—only a few plants at each locality. Plants 15 inches high June 15, 1908, and ten inches high July 1, 1912, but showing no flower buds; in flower and with mature fruit Sept. 19, 1899.

EPILOBIUM COLORATUM Muhl.

Rather common in low grounds or wet places. Plants several inches high June 28, 1912; observed in flower late in September.

* EPILOBIUM ADENOCAULON Haussk.

Not rare, occurring in low grounds or damp thickets. Tom Nevers Pond and swamp, Taupawshas Swamp, Shimmo, Coskaty. Freshly in flower Aug. 7, 1906, in flower and with mature fruit Aug. 30, 1904, some flowers Sept. 19, 1899. Plants of pronounced character were collected in Tom Nevers swamp, the leaves 6–9 cm. long by 2–2.5 cm. broad. The flowers are commonly larger and much deeper in color than those of *Epilobium coloratum.*

OENOTHERA BIENNIS L.

Common in fields and open places, in thickets and woodland and as a weed in waste and in cultivated ground, flowering from midsummer through September. First flowers July 6, 1912. Its widely varying forms seem to hint at more than one species and appear to include crosses with *Oenothera muricata.* There are long pod forms and short pod forms that display marked contrasts. In the former the capsules are tapering linear and rather prominently quadrangular, becoming 4 cm. long and 4–5 mm. wide at the base; in the contrasted form they are commonly 2–3 cm. long and 5–7 mm. wide, less tapering and more abruptly contracted at the apex and with more rounded angles; in both forms the capsules may be either densely pubescent or glabrate. The flowers are commonly 4–5 cm. wide but are sometimes considerably smaller; the largest seen were 6.5 cm. wide on plants that after having been partly cut down had

recovered their growth. A form found on the eastern side of the island was noteworthy from the shiny and bright red-purple sparsely pubescent stem and branches which, with the subglabrate capsules, were viscid to the touch; the flowers and capsules were of medium size, the thin leaves lanceolate, with attenuate base and apex, the lowermost slender petioled.

* OENOTHERA MURICATA L.

Common, especially along shores, often in pure sand, but also in sandy and gravelly spots in all parts of the island. First flowers July 8, 1912; flowering through September.

Professor DeVries who, on his first visit to America, looked over some of my Nantucket and Long Island specimens of this *Oenothera* pronounced them to be essentially the same as the introduced American plant growing in Holland known to him as *O. muricata* L. Miss Vail has recorded (Carnegie Inst. Wash. Publ. No. 81: 74) that "*O. muricata* L. raised from seed received from Professor DeVries from the Holland sand dunes resembled these American plants but were not absolutely identical."

As compared with *O. biennis* this is a lower and more leafy-bracted plant with more numerous and ascending leaves of narrower form and thicker texture and less definitely repand denticulate, the lower with oblanceolate tendency; the general pubescence is softer, denser and more appressed, the longer hairs tending to form a villous or even pilose investiture especially on the capsules. In *O. biennis* the sparser pubescence is harsher and more or less hirsute, the smaller hairs mostly erect and incurved; the seeds are considerably smaller than those of *O. muricata*.

* OENOTHERA STRIGOSA (Rydb.) Mackenzie & Bush.

On June 19, 1910, many plants of this western species were found scattered through a once cultivated field on the Cabot farm in Shimmo valley; they were in full flower and a few bore capsules already 2 cm. in length. Specimens collected agree closely with the types of *O. strigosa* in the Herbarium of the New York Botanical Garden. Doctor Rydberg, who made the comparison with me, concurs in the determination. The plant seems to be new to our eastern flora and must be supposed to have been recently introduced. It was perhaps only transient at the Cabot farm

since it was not to be found there in June of the two years following its discovery. The plants, although well flowered and having stout roots, were unbranched and were rather contracted in habit as if repressed by some unfavorable condition of soil or surroundings. They were 2–4 dm. high, the simple stem sulcate, the crowded leaves rather undersized and erectly ascending, thickish and light green, the lowermost already turning purplish-red, pubescence dense and subappressed, of soft and somewhat silky hairs; flowers at first bright yellow becoming pinkish-red basally or throughout; petals 1.5–2.5 cm. long, 2.2–2.5 cm. wide, obovate, rounded or truncate; hypanthium 2–2.5 cm. long; flower buds abruptly narrowed or rounded to the apex; sepal tips very short. The earlier flowering period as compared with that of our native eastern species is especially to be noted.

Another closely allied *Oenothera*, *O. canovirens* Steele, described from Illinois (Contr. U. S. Nat. Herb. **13**: 365. 1911), is not very different from this, but its longer hypanthium and longer sepal tips appear to be well marked distinctive characters, and other differences in the specimens I have seen lead me to think it a valid species. It is clearly not the same as *O. subulifera* Rydb. from Montana* which is also characterized by long sepal tips.

It may here be recorded that *O. canovirens* also occurs on the Atlantic seaboard. As long ago as Aug. 9, 1906, I collected it at Van Cortlandt, New York City, and put aside specimens under a manuscript name as a new species. These have been deposited in the herbarium of the New York Botanical Garden. My notes record that the flowers were not fragrant as were those of *O. biennis* with which it grew. A less densely pubescent form of *O. canovirens* was collected at Lynbrook, Long Island, July 3, 1910, growing along a new made roadway; the flowers were conspicuous from the reddish orange suffusion towards the base of the petals.

* OENOTHERA OAKESIANA Robbins.

Scarce; found only along a roadside northwest of the town and below the "Cliff." In flower and with small capsules Aug. 4, 1906; mature fruit Sept. 9, 1904. The Nantucket plant agrees closely with the plant of the Hempstead Plains, Long Island.

* Bull. Torrey Club **40**: 66. 1913. *O. strigosa subulata* Rydb. Mem. N. Y. Bot. Gard. **1**: 279. 1900.

specimens from both places were used by Doctor MacDougal in his "Mutation Studies," 1904.

*** Oenothera stenopetala** sp. nov.

Dwarf, 1–4 dm. high, erect, often geniculate at base, simple or sparingly branched, the branches ascending, often surpassing the main stem; root woody, slender and elongated, mostly simple or nearly so; stem pale brown, sometimes slightly reddened below when old, lignescent and terete below, the bark early splitting and exfoliating in thin strips; above, and the branches, somewhat angled decurrently from the insertions of the leaves, closely appressed canescent-puberulent, sometimes thinly short strigillose above. Leaves often erectly ascending, pale green, narrowly oblong to linear-oblanceolate, 4–7 cm. long, 5–10 mm. wide, acute or subacute, the lower tapering into slender petioles, the uppermost and the bracts sessile with tapering base, or, even the bracts also, sometimes short petioled, entire or obscurely repand denticulate, on both surfaces finely white pubescent with appressed hairs; flower buds densely appressed strigillose and downy puberulent with gland tipped hairs; hypanthium very slender, 2–3 cm. long, glandular-puberulent; sepals 7–12 mm. long, glandular-puberulent and subpilose, the apical process subterminal, about 2 mm. long; petals narrowly linear, pale yellow, spreading, at length reflexed, puberulent on the outer surface and often slightly so within, 10–22 mm. long, 1.5–3 mm. wide; stamens longer than the style; filaments becoming 10 mm. long, anthers 3–4.5 mm. long; capsule tapering from the base or from above the middle to a narrowed apex, quadrangular with rounded angles, 2.5–3.2 cm. long, 5–7 mm. wide, when young whitened with a dense appressed subsericeous pubescence becoming appressed pubescent and slightly strigillose.

Type Aug. 15, 1906, in Herbarium New York Botanical Garden.

Found only along the sandy embankments of the railroad beyond the Orange Street crossing, where it was common in 1906 and 1907. In full flower and with some immature pods Aug. 5, 1906; still in flower, and with full sized pods Aug. 15; a few last flowers Sept. 11, 1907. On June 19, 1908, the larger plants were 3–4 inches high.

It is interesting to find that this plant was collected on Nantucket by Morong as long ago as Aug. 31, 1871, as evidenced by a flowering specimen in the Herbarium of the New York Botanical Garden labeled by Mr. Morong's hand "*Oenothera biennis* var.

parviflora." Others have also found the plant there, for Mr. Floyd's notes refer to collections as follows: Orange street, 1904, Mrs. Nellie F. Flynn; roadside near Maxcys Pond, 1905, Joseph R. Churchill, both determined as *O. cruciata* Nutt.

Notwithstanding the narrowly linear petals of this the smallest of our *Oenotheras* there can be little doubt that its real affinity is not with *O. cruciata*, a near relative of *O. biennis*, but rather with *O. Oakesiana* with which it agrees closely in pubescence and to some extent in the form of the capsule. *Oenothera cruciata*, which would be quite out of its known range on Nantucket, is an altogether larger and to an extent a glabrate species becoming thinly papillose hirsute with stiff spreading hairs. It differs throughout from the Nantucket plant; the bracts subtending the flowers are broad based, not narrowly tapering or petiolulate; the sepal tips are twice longer; the linear petals are materially shorter, never apparently becoming much more than half the length of the longest in *O. stenopetala*. As compared with *O. Oakesiana*, *O. stenopetala* is a much smaller plant; its pubescence although similar is less dense and canescent, sometimes taking an appressed strigillose character, especially on the broader based and shorter capsule; the cauline leaves are longer petioled and less sinuate or not at all so; the bracts are more narrowed to the base, the sepal tips much shorter and subterminal, the petals different beyond comparison.

An ambiguous *Oenothera*, which grew near *O. stenopetala*, seemed quite intermediate in pubescence and leaf characters between that species and *O. muricata* and appeared like a hybrid between them. The flowers were very small but with the petals quite as broad as long, mostly 10 mm. or less in length and breadth, a few as much as 15 mm. This plant is also suggestive of *O. Oakesiana* but the pubescence is coarser, the leaves more entire, the capsules stouter and less crowded and with more foliaceous bracts and the sepal tips are terminal and very short.

* OENOTHERA LAMARCKIANA DeVries.

Not *O. Lamarckiana* Seringe (1828). See Davis, Bull. Torrey Club **39**: 519–533. *pl. 37–39*. 1912.

The occurrence of this now storied plant on Nantucket as an estray from cultivation has already been reported by MacDougal

(Carnegie Inst. Wash. Publ. No. 81: 6. 1907). It was found in August, 1904, in the neglected yard of a small house on lower Union Street, where it had spread among the grass and weeds and strayed outside the fence into an adjoining waste lot. Inquiry gained the information that a number of years before it had been raised from seed that had been given to the then occupant of the premises. It could be seen that the plant had spread naturally from two small and long undisturbed flower beds now almost obliterated by an incursion of weeds and grass. The specimens submitted to Doctor MacDougal were collected Aug. 29, 1904, bearing flowers and mature fruit. Other specimens were collected Aug. 15, 1906. In September, 1907, it was found that a general clearing up of the locality had almost exterminated the plant and a straggling individual in the yard and one in the adjoining lot were all that could be found. Subsequently, with further alterations in the surroundings, the plant had disappeared. But on a transient visit to Nantucket, Sept. 28, 1912, the same *Oenothera* in full flower was seen in almost complete possession of a small uncared for yard in a built up part of the town.

The flowers are remarkably showy, the petals bright golden yellow, the sepals deep purplish red in marked contrast. The largest corollas were 12.7 cm. across the expanded petals, the smallest less than half that size (6 cm.). No fragrance was perceptible. On bright days they open late in the afternoon closing in the forenoon of the following day. The capsules were 2.8–3.2 cm. long, papillate-hirsute, and glandular-puberulent with minute spreading hairs; seeds 1.5–2 mm. long, distinctly wing angled, wrinkled-lineate and rugulose.

Doctor MacDougal in his "Mutation Studies" of this species took seeds from the Nantucket specimens collected in 1904 and sowed them in sterilized soil in November of the same year. "On Jan. 27, 1904 [1905], 24 plantlets representing the widest diversity observable were transplanted to small pots in accordance with the usual practice. Six of these corresponded quite exactly to the mutant *O. albida* . . . all the other individuals developed in accordance with qualities of *O. Lamarckiana* with a maximum amount of color in the buds and also a maximum number of basal branches of some length" (Carnegie Inst. Wash. Publ. No. 81: 6. 1907).

* KNEIFFIA PUMILA (L.) Spach.

Not uncommon and actually widely scattered on the island, but very local. A few dried up plants were met with in September, 1899, below the "Cliff," where it was not seen again until June, 1910, when it was fairly common. It occurs also in meadows and low grounds in Squam towards Polpis; near the Polpis schoolhouse; in the "Thorn Lot"; about a mile west of the town; at the Weweeder Ponds; the "Woods," at two stations, and by the Sheep Pond in the southwestern corner of the island.

Green buds only June 9, 1909; first flowers June 9, 1911; in full flower and with small pods June 15, 1910; still in bloom July 11, 1912.

Specimens from below the "Cliff," collected June 15, 1910, have reddened stems and flower buds and calyces of a bright purplish red. At all other localities the plants were without any obvious reddish tinge.

CIRCAEA LUTETIANA L.

Frequent in thickets on the eastern side of the island from Shawkemo to Squam and Coskaty. First flowers July 11, 1912; mature fruit Sept. 17, 1907; fruit mostly gone Sept. 20, 1907.

HALORAGIDACEAE

PROSERPINACA PALUSTRIS L.

Common in the borders of muddy ponds and in pools and ditches. Just in flower July 2, 1912.

MYRIOPHYLLUM TENELLUM Bigel.

In abundance along the muddy borders of a pond west of Madequet ditch, growing in exposed spots as well as among the cat-tails. In full flower July 10, 1912. Mrs. Owen has recorded that it was found by her in Cains Pond in 1858.

MYRIOPHYLLUM HUMILE (Raf.) Morong.

Common in ponds and pools or, where the water has receded, on drying mud. At Maxcys Pond, Sept. 12, 1907, the terrestrial form was abundantly in flower and fruit, the submersed form in fruit only, and very sparingly. On Sept. 10, 1899, the form with emersed spikes bore both fruit and flowers. In all three phases of

the plant the carpels, about 1.25 mm. long, were prominently tuberculate or minutely papillose-roughened, often with a smooth dorsal space between two indistinct ridges. Occurs on Tuckernuck.

ARALIACEAE

ARALIA NUDICAULIS L.

Not common and found only in the dense thickets on the eastern side of the island from Shimmo to Polpis, Pocomo and Squam; also at Tom Nevers Swamp, and on Tuckernuck. Just in flower June 2, 1909.

UMBELLIFERAE

HYDROCOTYLE UMBELLATA L.

One of the most common aquatics of Nantucket having found its way into almost all of the fresh water ponds and pools. Also on Tuckernuck. The floating leaves begin to appear by the end of May. In full flower and fruit through September.

* SANICULA MARYLANDICA L.

This is one of the plants of Nantucket that have been found only at a single spot. On July 4, 1912, I came upon a thriving colony of about fifteen plants hidden in the seclusion of a thicket in Squam not far east of Watts Run; they were in full flower and well set with young fruit. This species is frequent in the thickets of Chappaquiddick Island, Marthas Vineyard.

* SANICULA CANADENSIS L.

Also found only at a single station, and only one plant. It grew at the border of a thicket in Squam towards Wauwinet, Aug. 13, 1906, a well-fruited plant nearly 9 dm. high. It is scarcely to be doubted that other plants are to be found among the extensive and almost impenetrable thickets in that part of the island although I have not succeeded in rediscovering it. It occurs on Marthas Vineyard and I know of a single colony on Chappaquiddick Island.

* CONIUM MACULATUM L.

Occasional in waste ground about the wharves and in the outskirts of the town. Some plants were already nearly five feet tall June 4, 1911, the umbels still close and green. In full flower June 29, 1912.

* PETROSELINUM HORTENSE Hoffm.

A weed in a garden, 1897, Mrs. Nellie F. Flynn. Possibly merely persistent after cultivation. A specimen received from Mrs. Flynn was collected Aug. 16, bearing mature fruit.

* CICUTA MACULATA L.

Capaum Pond, May 30, 1909, a single tuft 14 inches high on the west side of the pond back of the beach. Not seen since. Met with at two localities on Marthas Vineyard.

* CICUTA BULBIFERA L.

Mrs. Nellie F. Flynn has sent me for examination a specimen of this species collected Aug. 18, 1899, in a ditch near Shawaukemmo spring. It is a stout plant, 8.5 dm. tall, in full flower and bearing many clusters of young bulblets. Mrs. Flynn has now no recollection of having seen more than this one plant, the only one known ever to have been collected on Nantucket.

SIUM CICUTAEFOLIUM Schrank.

Common about the borders of fresh water ponds and in swamps and ditches. The leaves are well developed at the end of May. First flowers July 11, 1912.

PTILIMNIUM CAPILLACEUM (Michx.) Raf.

Abundant in damp places in either fresh or brackish soils. The seedling plants become visible early in June and are in full flower and fruit in September.

* AETHUSA CYNAPIUM L.

Occasional about the wharves and by street sides in the town. On every visit to Nantucket I see it somewhere, but never more than a few plants, and usually at some new locality. Umbels showing white June 4, 1911; first flowers June 10, 1909; in full flower and fruit in September.

* ANETHUM GRAVEOLENS L.

Mrs. Flynn has sent me specimens of this plant collected by her from a large clump growing in a waste spot among the Scallop houses near the harbor shore.

LIGUSTICUM SCOTICUM L.

In abundance along the shores of Baches Harbor and Polpis Harbor and on the western side of the island at Great Neck and Little Neck. It also grows at the ice houses by Maxcys Pond where it has doubtless come in with eel grass taken from the sea shore. On the south side of the island it was seen only by Madequecham Pond, a single tuft. A dense cluster at Little Neck in 1904 was six feet across. No flowers observed up to the first week in July; fruit in all stages of maturity may be found early in September and flowers until late in the month. Locally common along the shores of Edgartown Harbor, Marthas Vineyard.

* CORIANDRUM SATIVUM L.

Well established through an abandoned weedy yard at the south end of the town; in full flower June 28, 1912.

* COELOPLEURUM ACTAEIFOLIUM (Michx.) Coult. & Rose.

At Wauwinet many plants of this stout umbellifer are scattered through the low bayberry thickets that clothe the bank above the harbor shore. They were in full flower July 11, 1912, and bore many umbels still undeveloped as well as others heavy with mature fruit. The largest plants were over four feet high. In the same thickets the cow parsnip (*Heracleum*) had long since flowered and was completely dried up. A single large plant of the *Coelopleurum* in flower and with young fruit was found at the border of a low field near the shore on Beach Street, June 6, 1911. It had doubtless been introduced there, more than probably from the Wauwinet locality some eight miles up the harbor. Nantucket seems to be the southernmost point to which this northern plant has made its way.

* PASTINACA SATIVA L.

A casual weed of fence borders and waste ground. It is of frequent occurrence by roadsides south of the town and about Milestone farm but is not often met with elsewhere; near Millbrook swamp Aug. 9, 1906. First flowers June 12, 1909, June 19, 1910.

HERACLEUM LANATUM Michx.

Common all along the harbor in the northeastern quarter of the island from Shimmo to Wauwinet, growing up among the shrubbery back of the beaches and in the shore thickets; too common and vigorous among the rarer native plants on Rattlesnake bank; Polpis; west of Sankaty. Tuckernuck. First flowers June 2, 1909; conspicuously in bloom June 7, 1908; a few last flowers June 29, 1912.

DAUCUS CAROTA L.

Very abundant, whitening fields and pastures through July, August and September. The green umbels begin to unfold about the middle of June and the flowers become noticeable early in July. First flowers June 26, 1910, June 27, 1912; umbels frequently pink.

CORNACEAE

CHAMAEPERICLYMENUM CANADENSE (L.) Asch. & Graebn.

Cornus canadensis L.

Rare, but abundant at one locality in Shawkemo near Quaise where in a damp shaded thicket it fairly carpets the ground; it occurs also, but sparingly, in a thicket in Polpis. First flowers June 4, 1909; in full flower June 7, 1908.

CYNOXYLON FLORIDA (L.) Raf.

Cornus florida L.

Not rare among the extensive thickets in Squam where I have come upon it at perhaps half a dozen stations, single trees or a few together, except in one instance where as many as thirty, most of them in poor condition, formed a close group. The trees are mostly well matured but not over ten or twelve feet high. At Beechwood in Polpis it is more numerous and of freer growth, the larger trees having attained a height of certainly 18–20 feet. I have seen it elsewhere on Nantucket only near the state road a mile or so west of Siasconset, where a dense thicket conceals a cluster of several old trunks of widespread branchment but not over 4–5 feet high, the lower branches nearly prostrate. At Beechwood it was in full flower June 12, 1909. A group of small trees was found on Tuckernuck, June 17, 1911.

* CORNUS AMOMUM Mill.

Fringing a brook along the north side of Trots swamp; a second locality is at Capaum Pond where there are several thick clusters near the shore on the west side of the pond. Cymes just appearing June 10, 1908; in full flower July 12, 1910; ripe fruit Sept. 12, 1907.

NYSSA SYLVATICA Marsh.

A common tree on the eastern side of the island, wanting over much of the western side; small trees grow on Coatue. Tuckernuck. It is ordinarily not taller than 8–10 feet, although trees 15 feet high are not uncommon; in Pocomo are groups of larger trees over twenty feet in height, and in Beechwood are some that are certainly not less than 30–35 feet high, equalling in height the tallest red maples. Probably there are no taller native trees anywhere on Nantucket. The trunks of these were not as thick as those of lower trees on Pocomo where the largest seen was 28 inches in circumference. A still stouter trunk of a not particularly tall tree in Quaise was 35 inches around one foot above the base. Coming into leaf June 3, 1909; anthers visible but not yet mature June 8, 1911, June 15, 1908; in full flower and with small green fruit June 20, 1910.

Phytogeographical notes on the Rocky Mountain region
II. Origin of the alpine flora*

P. A. Rydberg

When studying the flora of a certain region or district, one naturally asks himself the following questions: What is the origin of these plants? Where did they come from? How did they come there? Where else are they found? Why are they found there and not in adjacent territory? Why are they there and not in other similar regions? Why are other plants found in similar regions and not there? Many other similar questions might be asked and none of them could be satisfactorily answered. We can only make suggestions and surmises. Some answers may seem satisfactory to us now, as others may have seemed satisfactory to generations gone by; others may seem merely probable, and still others not even so. The alpine regions of the Rockies are merely small isolated spots, when the whole mountain range is considered. They can be compared with a number of small islands, now surrounded (so far as many of the species are concerned) by barriers insurmountable, more so even than islands in an ocean could ever be. It is far easier to tell what an alpine plant is (and I have already in a former paper tried to give a definition thereof) than to tell how it came there. If we had only endemic species to deal with, we should perhaps explain its existence by a spontaneous generation or as something originated from a related species, which exists or has existed in the subalpine region below. The belief in a spontaneous generation, at least so far as the higher plants or animals are concerned, is now generally discarded. The derivation from related species of the subalpine region is in many cases a satisfactory explanation of the existence of many endemic alpine species but not of all. But how shall we explain the existence of the same plant in the alpine regions of Colorado and the Alps in

* In this paper the sedges have been omitted, as they have not yet been worked up. Without an authentic determination of the species, it is risky to discuss such a critical genus as *Carex* in a phytogeographical paper.

Europe, as for instance *Potentilla nivea*, *Lloydia serotina* and *Viola biflora?* This question leads to other related ones. Has a species originated only once or can the same plant arise at the same time or at different times at two or more isolated localities? Are the individuals of *Potentilla nivea*, now growing in Colorado, in the Alps, in Scandinavia, in Greenland, etc., offsprings of the same parent *Potentilla nivea* living ages ago, or did the species originate independently at the different places? In the case of *Potentilla nivea*, I rather think that it is monotypic and has had a much more general distribution than it now has, for it is a common plant in the arctics. But this is not the case with *Viola biflora*, which is not an arctic plant. Until lately the only localities known in this country were in Colorado, but now it is known also from Alaska.

It is not, however, impossible that some so-called species have had a polytypic origin. *Primula farinosa* is a plant of the Alps, northern Europe, northeastern America, and apparently the same plant is found in south Chile to Terra del Fuego. In both cases, however, the plant itself or else the parent plant, from which it originated, must have had a much greater distribution than it now has. We know of many plants which in earlier periods have been distributed over much greater territory than they now are, as for instance *Ginkgo biloba* and *Taxodium distichum* were once found in Europe, while they now are restricted, the former to northeastern Asia and the latter to the southern United States.

It was stated before that many of the alpine plants of the Rockies are also arctic or subarctic, and as far as the Rockies are concerned the seeds could be carried by wind and animals from mountain top to mountain top, as the stretches are not so far, the mountain chain running north and south, but this would not be a satisfactory explanation in Europe and Asia where the principal chains run east and west and at a great distance from the arctic. Another explanation must therefore be given. The most plausible and most generally accepted theory concerning the origin of the alpine flora is the following. In the glacial periods, the regions in front of the ice-sheet became unfit for the woody vegetation and in fact for all plants except the arctic-alpine elements. The forest receded south in front of the advancing ice. The temperature in the mountain regions south thereof became lower and lower, the

glaciers increased and extended downwards and the forests receded down the mountain sides. At last the foothills and even the plains of northern Europe, Asia and America received an alpine-arctic climate and bore mostly arctic vegetation. As the ice sheet receded, the climate became more temperate, the forest again took possession of the land and the arctic plants were partly driven towards the pole, partly up the mountains, until in our days they are confined to the arctic regions and the highest mountain tops, where they have become isolated. In America the glacial drifts did not reach as far south as Colorado, but evidently the temperature during the glacial epoch must have been low enough, so that the local glaciers of the Rockies may have covered most of the mountains, and the great plains and the foothills surrounding them undoubtedly had an arctic or subarctic climate at that time. Many of the arctic plants had originated before the glacial period and had spread over the two continents. Some of these still exist on both, others might have died out on one of the continents, but remain on the other. Some might become exterminated in the mountain regions while continuing their existence in the arctic regions, or vice versa. Some, after isolation, might have changed in the course of time and developed into new species. This is perhaps more common in the case of the alpine than of the arctic plants. The arctic-alpine plants may therefore be classified in the following categories.*

1. Circumpolar arctic-alpine or glacial plants, found in the arctic as well as in the mountain regions of both continents.

2. Eurasian arctic-alpine or glacial plants, found only in the mountains of the Old World and the arctic regions. Some of these may be:

(*a*) European arctic-alpine or glacial plants, with the center of distribution in the Alps;

(*b*) Asiatic arctic-alpine or glacial plants, with the center in the Altai.

3. American arctic-alpine or glacial plants, confined to the mountains of the New World and the arctic.

* Here I do not include the alpine plants of tropical regions, which must be considered altogether by themselves.

4. Eurasian alpine plants, found in the mountains of the Old World, but not in the arctic regions. The principal subdivisions of this group are:

(*a*) Alpestrian, endemic plants of the European Alps, including the Pyrenees and the Caucasus;

(*b*) Altaic, north Asiatic alpine plants.

5. American endemic alpine plants. The principal regions of these are the following:

(*a*) Sierra Nevada, including the Cascade Mountains, which latter, however, contain an intermixture of some elements belonging to the next;

(*b*) Rocky Mountains, including the San Francisco Mountains and the other ranges of Arizona, New Mexico and northern Mexico;

(*c*) White Mountains. Most of the plants of this region belong to the arctic-alpine group, but endemic alpine plants are not wholly lacking, as for instance, *Potentilla Robbinsiana* and *Sieversia Peckii*.

6. Circumpolar arctic plants, not found in the mountains.

7. Eurasian arctic plants, which do not concern us at all.

8. American arctic plants.

9. Subarctic and

10. Subalpine plants, which encroach on the arctic and alpine regions.

CIRCUMPOLAR ARCTIC-ALPINE OR GLACIAL PLANTS

These species probably had originated before or during the glacial epochs. In some cases the origin probably was somewhere in the Old World, in others in the New World. Of course, we cannot know, but we may surmise. The region which contains the most numbers of certain groups of species may probably be the place where this group originated (*i. e.* the home of the parent species) and where the individual species sprang from. As for instance, there is a group of arctic-alpine species of *Potentilla* with ternate leaves white-wooly beneath. *Potentilla nivea* is the most generally distributed species of the group; it is also the first and best known. Where is the probable ancestral home of this species? The species is found in Europe, rather common in the Scandinavian mountains,

but not so common in the Alps. It is the only species of the group there. It is, therefore, not probable that its ancestry came from that region. The group is represented in both North America and Asia by several species. The American species, except *P. nivea* and *P. uniflora*, are rather local, and are modified to adapt themselves to local conditions. Both *P. nivea* and *P. uniflora* as well as *P. villosa* (found in the northwestern corner of this continent) are found in Asia, together with several others of the group. *P. nivea* itself is common there in the mountains as well as in the arctic, while it has been collected only at a few places in the Rockies of Colorado. It is therefore probable that the group originated in Asia.

Let us now discuss the plants of this category. The following plants are common to the arctic regions of both continents, the Alps, and the Rockies as far south as Colorado. Most of these are also found in Asia. Those with a star are also found in the subalpine regions.

**Phleum alpinum*
**Trisetum subspicatum*
**Deschampsia caespitosa*
Poa cenisia
**Poa alpina*
Festuca supina
**Festuca ovina*
**Festuca rubra*
Juncus triglumis
Juncus castaneus
**Juncoides spicatum*
Lloydia serotina
Salix reticulata
Oxyria digyna
**Bistorta vivipara*
Silene acaulis
Thalictrum alpinum
Ranunculus pygmaeus
Draba fladnizensis
Muscaria adscendens
Potentilla nivea
**Astragalus alpinus*
Campanula uniflora
Myosotis alpestris

Some of these species extend into mountains situated so far south that they could not have been connected with the arctic regions even in the glacial times. The existence of these species there has to be explained in some other way. In most cases their seeds were probably carried by birds or other animals or by the wind. Included among such plants are the following:

Lloydia serotina, a typical arctic-alpine plant, is found not only in the arctic regions, the mountains of northern Europe and Asia, the Alps, the Rockies and the Sierra Nevada, but also in

mountains farther south, as the Pyrenees, the Caucasus, the Himalayas, and, in America, in the San Francisco Mountains, Arizona. Like most bulbiferous plants, it does not readily propagate by seeds, but when these are formed, they may easily be distributed by the wind on account of their flatness.

Juncoides spicatum has about the same distribution except that it is not found in the Himalayan region. The seeds of this species must have been carried by birds as they are too heavy to be carried by wind.

Poa alpina extends south to the Sierra Nevada (Spain), the Appennines, and the Himalayas, and *Trisetum subspicatum* and *Phleum alpinum* extend in America south through the mountains of Mexico, Central and South America. As these grasses also are subalpine, their seeds have probably been distributed by animals.

The following two species are common to the arctic regions of both hemispheres, to the Rockies, and to the Asiatic mountains, but not found in the Alps: *Draba glacialis* and *Anemone parviflora*.

Saxifraga cernua and *Campanula uniflora* are circumpolar glacial plants, but do not reach the Alps. They are found in America as far south as Colorado and Utah. Either these plants are of American origin and have extended their range over northern Europe, or else they have perished in the Alps.

The same may be said about *Micranthes hieracifolia*, although it does not reach the southern Rockies.

Aster alpinus is a glacial plant found both in the Alps and the Altai, rare in the Rockies and lacking altogether in the Scandinavian mountains.

Some of the circumpolar glacial plants, although they are found on this continent, are found neither in the southern Rockies nor in Sierra Nevada, although they are found in both the Alps and the Altai. Such are:

Cerastium alpinum	*Chondrosea Aizoon*
Erigeron alpinum	*Micranthes nivalis*

The first two are, however, represented by related endemic species.

A few of these circumpolar plants are found in the Alps, but neither in the Altai nor in the southern Rockies, as for instance

Tofieldia palustris. This is found in Great Britain, Scandinavia, northern Russia, the Alps, the Pyrenees and the Ural. Notwithstanding the fact that it is less distinctly arctic-alpine than for instance *Lloydia serotina* and has been collected in the lowland as far south as Two Harbors, Minnesota, it has not been collected in the Rockies south of northern Montana.

ASIATIC ARCTIC-ALPINE OR GLACIAL PLANTS

Dasystephana glauca is a distinctly Asiatic glacial plant, but also found in western North America, coming down south as far as Montana.

AMERICAN ARCTIC-ALPINE OR GLACIAL PLANTS

A large number of the alpine plants of the Rockies are strictly American glacial plants, i. e., found both in the mountains and the arctic regions of this continent but not in the mountains of the Old World.

1. In many cases they are there represented by closely related plants. In such cases the history of the plant might be the following:

(*a*) That the parent plant had a circumpolar distribution before or during the earlier part of the glacial period and the two related species developed independently from it;

(*b*) That the Old World plant existed on both continents during the glacial epoch and became modified after isolation on this side; or

(*c*) That the American plant existed and became modified abroad.

Here I give a list of such plants and the nearest relatives in the Old World.

AMERICAN	EUROPEAN	ASIATIC
**Calamagrostis purpurascens*	*C. arundinacea*	
Salix glaucops	†*S. glauca*	
Salix chlorophylla	*S. phyllicifolia*	
**Alsinopsis propinqua*	*A. verna*	

* Those starred are also subalpine and subarctic.

† *Salix glauca* and *Rhodiola rosea* are also found in northeastern America, but not in the Rockies.

AMERICAN	EUROPEAN	ASIATIC
Alsinopsis quadrivalis	*A. verna*	
Alsinopsis Rossii	*A. verna*	
Anemone zephyra	*A. narcissiflora*	*A. narcissiflora*
Ranunculus affinis		*R. pedatifidus*
Smelowskia americana		*S. calycina*
Rhodiola integrifolia	†*R. rosea*	
Leptasea austromontana		*L. bronchialis*
**Potentilla quinquefolia*	*P. nivea*	*P. nivea*
Potentilla nipharga	*P. nivea*	*P. nivea*
Vaccinium oreophilum	*V. Myrtillus*	
Androsace carinata	*A. Chamaejasme*	*A. Chamaejasme*
Androsace albertina	*A. Chamaejasme*	*A. Chamaejasme*
**Swertia palustris*	*S. perennis*	*S. perennis*
Amarella monantha	*A. tenella*	*A. tenella*
Amarella plebeia	*A. Amarella*	*A. Amarella*
Dasystephana Romanzovii	*D. Froelichii*	*D. frigida*
Condrophylla americana	*C. prostrata*	*C. prostrata*
Polemonium pulcherrinum		*P. humile*
Erigeron simplex	*E. uniflorus*	*E. uniflorus*
Erigeron melanocephalus	*E. uniflorus*	*E. uniflorus*
Artemisia saxicola	*A. norvegica*	
Artemisia spithamaea		*A. borealis*

Many of the endemic American glacial plants—or rather alpine-arctic plants, for most of them undoubtedly originated after the glacial period—are evidently derived from existing circumpolar glacial plants. Such are:

AMERICAN GLACIAL	CIRCUMPOLAR GLACIAL
Deschampsia curtifolia	*D. caespitosa*
Poa arctica	*P. cenisia*
**Festuca saximontana*	*F. ovina*
Agropyron biflorum	*A. caninum*
Cerastium Behringianum	*C. alpinum*
Draba andina	*D. glacialis*
Draba oligosperma	*D. glacialis*

Some of these arctic-alpine plants had probably the same

parents as some existing circumpolar-arctic plants. While one offspring has remained arctic, *i. e.* has not spread south during the glacial period or else has died out in the alpine regions, the other has become both alpine and arctic with a purely American distribution, or else the latter has developed from the former since glacial time. Such plants are:

NORTH AMERICAN ARCTIC-ALPINE	CIRCUMPOLAR ARCTIC
Chrysosplenium tetrandrum	*C. alternifolium*
Antennaria media	*A. alpina*
**Antennaria umbrinella*	*A. alpina*

A few strictly arctic plants have for some reason spread into the Rockies, their existence there being a little hard to explain. Among these may be mentioned *Phippsia algida*, which has been collected in one place in Colorado. It is otherwise not known out of the arctic. *Sagina nivalis* has been found in Colorado; otherwise only in the arctic regions of America and in the Scandinavian mountains.

The following are truly endemic American arctic-alpine plants without any close relatives as far as I know elsewhere:

Ranunculus hyperboreus	**Erigeron compositus* and its close relatives, viz.
Aragallus podocarpus	**Erigeron multifidus*
**Vaccinium caespitosum*	*Erigeron trifidus*

The following are probably derived from subarctic or subalpine species:

**Calamagrostis Langsdorfii*†	*C. canadensis*, American, subalpine and boreal.
**Alsine laeta*	*A. longipes*, American, subarctic, subalpine and boreal.
**Kalmia microphylla*	*K. glauca*, eastern American, subarctic and boreal.
**Senecio cymbalarioides*	*S. aureus*, eastern American, boreal.

† This is also found in subarctic Scandinavia.

AMERICAN ENDEMIC ALPINE PLANTS

More than one third of the alpine plants of the Rockies are endemic and if the subalpine element found just over the timberline, or occasionally higher up, is included, this proportion is increased to about half of all the species. Several of these are apparently derived from circumpolar glacial or arctic plants.

SOUTHERN ROCKIES	CIRCUMPOLAR GLACIAL OR ARCTIC
Deschampsia alpicola	*D. caespitosa*
Ranunculus Macauleyi	*R. nivalis*
Parrya platycarpa	*P. macrocarpa*
Leptasea chrysantha	*L. Hirculus*
Muscaria delicatula	*M. caespitosa*
Muscaria micropetala	*M. caespitosa*
Saxifraga debilis	*S. rivularis*
Saxifraga simulata	*S. cernua*
Potentilla modesta	*P. nivea* (perhaps through *P. quinquefolia*)

NORTHERN ROCKIES	CIRCUMPOLAR GLACIAL OR ARCTIC
Salix nivalis	*S. reticulata*
Draba lonchocarpa	*D. nivalis*
Muscaria monticola	*M. caespitosa*
Micranthes Rydbergii	*M. hieracifolia*
Micranthes crenatifolia	*M. nivalis*
Spathularia Vreelandii	*S. stellaris*
Phyllodoce empetriformis	*P. coerulea*
Phyllodoce glanduliflora	*P. coerulea*
Cassiope Mertensiana	*C. tetragona*

SOUTHERN AND NORTHERN ROCKIES	CIRCUMPOLAR GLACIAL OR ARCTIC
Micranthes rhomboidea	*M. nivalis*
Micranthes arnoglosa	*M. nivalis*
Taraxacum scopulorum	*T. arcticum*
Salix saximontana	*S. reticulata*

Others have no close relative on this continent, but may have the same origin as some Old World plants. A list of these is here given with the nearest relatives abroad.

NORTHERN ROCKIES	EUROPEAN	ASIATIC
Salix Dodgeana	*S. retusa*	
Alsine americana		*A. dichotoma*
Leptasea Van Bruntiae		*L. bronchialis*
Drymocallis pseudorupestris	*D. rupestris*	
Eritrichium elongatum	*E. nanum*	*E. villosum*

SOUTHERN ROCKIES	EUROPEAN	ASIATIC
Condrophylla Fremontii		*C. humilis*
Anthropogon barbellatum	*A. ciliatum*	
Eritrichium argenteum	*E. nanum*	*E. villosum*

Still other species are probably derived from, or have the same origin as, American glacial or American arctic plants.

SOUTHERN ROCKIES

Poa pudica	*P. arctica*, glacial
Festuca minutiflora	*F. brachyphylla*, glacial
Salix pseudolapponum	*S. glaucops*, glacial
Alsine polygonoides	*A. laeta*, glacial
Cerastium Earlei	*C. Behringianum*, glacial
Caltha rotundifolia	*C. biflora*, subarctic
Draba pectinata	*D. andina*, glacial
Rhodiola polygama	*R. integrifolia*, glacial
Polemonium delicatum	*P. pulcherrimum*, glacial
Castilleja Haydeni	*C. pallida*, arctic

NORTHERN ROCKIES

Agropyron andinum	*A. biflorum*, glacial
Agropyron latiglume	*A. biflorum*, glacial
Salix cascadensis	*S. arctica* or *S. anglorum*, arctic
Cerastium pulchellum	*C. Behringianum*, glacial
Caltha leptosepala	*C. biflora*, subarctic
Caltha cheledoni	*C. biflora*, subarctic
Phacelia Lyallii	*P. sericea*, glacial
Polemonium parviflorum	*P. pulcherrimum*, glacial
Erigeron pedatus	*E. multifidus*, glacial

NORTHERN AND SOUTHERN ROCKIES

Bistorta linearifolia	*B. bistortoides*, glacial
Acomastylis turbinata	*A. Rossii*, arctic
Acomastylis sericea	*A. Rossii*, arctic
Mertensia nivalis	*M. lanceolata*, glacial
Castilleja occidentalis	*C. pallida*, arctic

Many of the alpine plants of the Rockies have their nearest relatives among the subalpine or mountain plants of the region. Such are

NORTHERN ROCKIES

ALPINE	SUBALPINE
Potentilla perdissecta	*P. diversifolia*
Potentilla decurrens	*P. diversifolia*
Pseudocymopterus Tiedestromii	*P. montanus*
Bupleurum purpureum	*B. americanum* (related to *B. ranunculoides* of Europe)
Phacelia alpina	*P. heterophylla*

SOUTHERN ROCKIES

Avena Mortoniana	*A. americana*
Poa Pattersonii	*P. crocata*
Eriogonum xanthum	*E. flavum*
Aquilegia saximontana	*A. brevistyla*
Thlaspi coloradense	*T. glaucum* (also closely related to *T. alpestre* of Europe)
Thlaspi purpurascens	*T. glaucum* (also closely related to *T. alpestre* of Europe)
Cheirinia amoena	*C. Wheeleri*
Cheirinia nivalis	*C. Wheeleri*
Cheirinia radiata	*C. asperrima*
Aragallus foliolosus	*A. reflexus*
Primula angustifolia	*P. Broadheadae*
Phlox condensata	*P. caespitosa*
**Mertensia Bakeri* †	
**Mertensia lateriflora*	*M. lanceolata*
**Mertensia Parryi*	
**Mertensia viridula*	
Besseya alpina	*B. plantaginifolia*
Achillea subalpina	*A. lanulosa*

† Those marked with braces constitute groups of closely related species.

SOUTHERN AND NORTHERN ROCKIES

Poa Lettermannii	*P. crocata*
Poa rupicola	*P. crocata*
Anemone tetonensis	*A. globosa*
Drymocallis pumila	*D. glandulosa*
Solidago decumbens	*S. oreophila*
Solidago ciliosa	*S. scopulorum*

The following alpine plants have no close relatives and seem to have originated in the Rockies:

Agropyron Scribneri	*Oreoxis alpina*
**Claytonia megarrhiza*	*Oreoxis Bakeri*
Paronychia pulvinata	*Oreoxis humilis*
Ranunculus adoneus	*Polemonium viscosum*
Ranunculus stenolobus	*Polemonium Grayanum*
Delphinium alpestre	*Polemonium confertum*
Gormannia debilis	*Polemonium speciosum*
Telesonix Jamesii	*Polemonium mellitum*
Telesonix heucheriformis	*Polemonium Brandegei*
Potentilla saximontana	*Douglasia nivalis*
Potentilla minutiflora	*Douglasia montana*
Potentilla tenerrima	*Tonestus pygmaeus*
Trifolium nanum	*Tonestus Lyallii*
**Trifolium Parryi*	*Xylorrhiza coloradensis*
Trifolium montanense	*Xylorrhiza Brandegei*
Trifolium salictorum	*Rydbergia grandiflora*
Trifolium Brandegei	*Rydbergia Brandegei*
**Trifolium dasyphyllum*	*Artemisia scopulorum*
**Trifolium lividum*	*Artemisia Pattersonii*
**Trifolium stenolobum*	*Artemisia Parryi*
Trifolium attenuatum	*Senecio Holmii*
Trifolium bracteolatum	*Senecio taraxacoides*
Angelica Grayi	*Senecio Soldanella*
	Senecio petrocallis
	Senecio Porteri

AMERICAN ARCTIC PLANTS

Many plants which have their main distribution within the arctic regions of North America are also found in the northern

Rockies; only a few of these extend far enough south to reach the boundary of the United States. In other words, only a few of them reach Montana and still fewer northern Idaho.

Salix alexensis
Salix arbusculoides
Salix Barrattiana
Salix Drummondiana
**Tofieldia coccinea*
Micranthes foliolosa
Erigeron grandiflorus
Erigeron lanatus
Erigeron unalaschensis
Antennaria alpina
Antennaria monocephala
Artemisia Richardsoniana
Artemisia arctica
**Achillea borealis*
**Achillea multiflora*
**Senecio lugens*
Potentilla emarginata
Amarella arctophila
Amarella propinqua
Mertensia Drummondii
Castilleja pallida

Some of these arctic plants have a circumpolar distribution, as the following:

Juncus biglumis
Juncoides arcticum
Juncoides hyperboreum
Juncoides arcuatum
Androsace septentrionalis
Saxifraga rivularis
Draba nivalis
Draba alpina
Muscaria caespitosa
Micranthes nivalis
Cardamine bellidifolia
Mairania alpina
Cassiope tetragona
Pedicularis lanata
Pedicularis Oederi
Pedicularis flammea

The following are Asiatic-American arctic plants extending into the Canadian Rockies:

Cheirinia Pallasii
Potentilla uniflora
Potentilla villosa
Campanula lasiocarpa

SUBALPINE PLANTS

Besides these, there are many of the subalpine plants which occasionally are found above timber line. If the sedges, which I have not yet recorded, are excepted, the list contains 80 such species. There is no need of giving the list in this connection. If I should discuss in a subsequent paper the subalpine region, such a list would there find its place.

* Mostly subarctic-subalpine.

The alpine plants of all classes in the Rocky Mountains number about 250 species. The subalpine plants, which sometimes are found in the alpine region, are if the sedges are added over 100 in number. Hence about 350 species of flowering plants, or between 6 and 7 per cent. of the Rocky Mountain species, are growing within the alpine region.

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The propagation of medicinal plants*

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An understanding of the best methods of propagating medicinal plants is essential to their successful cultivation. Their cultivation or commercial production is not a new industry, in fact certain phases of it are extremely old, though poorly developed. However long some of them have been continued under cultivation, there are still many phases of their propagation which have never been investigated. Repeated crop failures in the production of henbane in England have occurred during the past thirty years, and still the most recent reports continue to mention the uncertainty of germination without any attempt at explanation.

This condition is now changing, and the last few years have seen a more general and widespread interest in the thorough investigation of a rather selected list of drug plants than was hitherto experienced. The organized efforts of the United States Department of Agriculture are conducive to the continuation of this interest. England, Germany, and Austria have not been slow in following the example of the United States, and are now advocating the national support of comprehensive drug plant investigations.

The success of these investigations must of necessity depend upon the readiness with which supplies of seeds and plants can be obtained, and the ease with which they may then be propagated. The means of propagating medicinal plants need not differ in the main from those employed for other economic forms. Seedsmen, nurserymen, florists and gardeners all have their special and well-perfected systems of propagation for their respective classes of plants. The questions involved in these systems are not only those for increasing the number of individual plants, but also those involving the blooming and fruiting periods, harvests, markets, special crops, improvements, and breeding operations. Any

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method of propagation which does not augment these conditions is soon abandoned. Also, in the case of medicinal forms, the problems of propagation, though essential of solution, are only supplementary to other more valuable and interesting ones. The improvement of drug plants through selective breeding and hybridization, their successful cultivation upon a commercial scale, with the involved questions of practical and economic production, are more attractive, but in the end are all dependent upon successful propagation.

With medicinal plants it is many times difficult to obtain sufficient materials from which to propagate. Isolated, restricted, and many times unknown regions of production, make it almost impossible to obtain either seeds or plants. Even syndicates and sometimes government control have so monopolized these regions that they are practically inaccessible to the individual investigator. In an effort to obtain sufficient material with which to evolve certain problems upon the cultivation and improvement of the more valuable drug plants, difficulties were soon encountered in locating reliable sources of supply. Any study of the methods of propagation must therefore consist of, first, the obtaining or locating of suitable materials and, second, the various methods by which these may be successfully propagated and perpetuated. The first part of this discussion will, therefore, deal with probable sources of seeds and plants and the second with their propagation.

A thorough search has been made in an effort to locate the best and most probable sources for these materials. The results are given under the following five divisions:

I. Commercial samples and shipments of crude drugs.
II. Crude drug merchants.
III. Individuals living in or near producing regions, or others carrying on investigations with similar plants.
IV. Public and private botanical gardens, experiment stations and other institutions.
V. Commercial seedsmen and nurserymen.

A discussion of these sources together with results obtained follows in the foregoing order.

I

From commercial samples and shipments of crude drugs in which the aerial parts of the plants are used, germinable seeds are often obtainable. Many lots of drugs must be examined, however, and large numbers of questionable seeds examined and tested. In addition to furnishing material for planting, this procedure also serves as a valuable means of accurately identifying some crude drug of questionable origin. The age of seed from this source is always unknown and considerable time must be allowed for possible failures in germination. Among the forms of which seed may be obtained in this manner are American wormseed (*Chenopodium ambrosioides*), angelica (*Angelica atropurpurea*), anise (*Pimpinella Anisum*), arnica (*Arnica montana*), belladonna (*Atropa Belladonna*), broom tops (*Cytisus scoparius*), buchu (*Barosma betulina*), cannabis indica (*Cannabis sativa*), capsicum (*Capsicum fastigiatum*), caraway (*Carum Carvi*), cardamom (*Elettaria Cardamomum*), castor bean (*Ricinus communis*), celery seed (*Apium graveolens*), cevadilla (*Schoenocaulon officinale*), coca (*Erythroxylum Coca*), colchicum (*Colchicum autumnale*), colocynth (*Citrullus Colocynthis*), conium (*Conium maculatum*), coriander (*Coriandrum sativum*), fennel (*Foeniculum vulgare*), goats' rue (*Galega officinalis*), grains of paradise (*Amomum Melegueta*), henbane (*Hyoscyamus niger*), jumbul seed (*Abrus precatorius*), larkspur (*Delphinium Consolida*), Levant wormseed (*Artemisia pauciflora*), lobelia (*Lobelia inflata*), nux vomica (*Strychnos Nux-vomica*), parsley seed (*Apium Petroselinum*), passion flower (*Passiflora incarnata*), poppy heads (*Papaver somniferum*), scullcap (*Scutellaria lateriflora*), senna (*Cassia acutifolia* and *C. angustifolia*), serpentaria (*Aristolochia Serpentaria* and *A. reticulata*), staphisagria (*Delphinium Staphisagria*), stramonium (*Datura Stramonium*).

Germination tests have been made upon a number of the above forms as follows:

American wormseed.....
Angelica.....Fair germination.
Anise.....
Arnica.....Three tests. No results.
Belladonna.....About 50 per cent. germination.
Broom tops.....No results.
Buchu.....5 per cent. germination.

Cannabis indica.....100 per cent. germination.
Caraway.....
Cardamom.....Two tests. No results.
Celery seed.....
Cevadilla.....One test. About 25 per cent.
Coca.....Four tests. No results.
Colchicum.....Three tests. About 5 per cent. from one.
Colocynth.....Most tests give from 5–10 per cent. germination.
Conium.....50 per cent. germination or over.
Coriander.....
Fennel.....
Goat's rue.....One test gave 5 per cent. germination.
Grains of paradise.....
Henbane.....Most tests give 5 per cent. germination, or more.
Larkspur.....100 per cent. from most tests.
Levant wormseed.....No results from 2 tests.
Lobelia.....
Nux vomica.....No results from 5 tests.
Parsley seed.....
Passion flower.....One test gave 3 per cent. germination.
Poppy heads.....All tests gave 100 per cent. germination.
Scullcap.....One test out of three gave about 5 per cent. germination.
Senna.....Most tests gave fair germination.
Serpentaria.....No results from 2 tests.
Staphisagria.....One test gave 3 per cent. germination.
Stramonium.....All tests gave 50 per cent. germination, or more.

Large numbers of seeds were used in most of these tests, and the conditions governing germination were varied to suit the requirements, in so far as they could be determined. It is to be noted that germination in most cases was low. Table IV gives details on most of these plants and on certain other miscellaneous drug plants.

II

Dealers in crude drugs will many times lend valuable assistance in searching for and supplying seeds and plants. Importers with foreign representatives and the foreign merchants themselves will sometimes request their agents and collectors to assist in such matters. No great diversity of forms, however, can be secured through these sources. They are restricted to those of which the seed constitutes the medicinal part, or to those in which the seeds are likely to appear with other plant parts. The forms thus obtainable are mostly included in the preceding list, though better seeds are sometimes furnished by the dealers upon special request for fresh material.

III

It is sometimes possible to locate individuals in different countries who have become interested in the collection of rare seeds and plants. Such sources are extremely questionable. While some individuals can furnish much good material, there are others who, though expressing much interest, cannot be depended upon to supply the proper species. Numerous instances of this have been recorded, an example of which may be noted where an enthusiastic druggist of Texas supplied fine specimens of *Monarda* for henbane, which he claimed was growing luxuriantly in his section of the state.

Local drug collectors may be considered here rather than with crude drug merchants. More strictly speaking, they are a class by themselves with many peculiarities and limitations. They are mostly illiterate persons, who take instructions poorly and disregard them when once in the field. A close personal association with many of them has revealed the fact that they are only capable of accurately identifying a very small number of medicinal plants. These usually occur among the monotypic genera and, when two or more closely related species are in question, are usually collected indiscriminately. One of the most intelligent collectors observed repeatedly brought in specimens of various species of *Asclepias*, upon requests and instructions for *Apocynum cannabinum* and *Apocynum androsaemifolium*. *Apocynum cannabinum* when finally located was supplied upon requests for both of the two species. Only recently a negro quack, who is held in high repute by the colored element of a considerable section, supplied *Apocynum androsaemifolium* upon request for *Leptandra virginica*. Another form supplied for *Asclepias tuberosa* will have to be grown to maturity before it can be identified. One collector was shown potted specimens of golden seal (*Hydrastis canadensis*), and stone root (*Collinsonia canadensis*), and failed to recognize either of them. Twin leaf (*Jeffersonia diphylla*) is repeatedly offered by local dealers for genuine golden seal. Both the leaf and root structures of these forms are quite distinct.

IV

In so far as their collections will permit, the botanical gardens and other similar institutions are of great value in supplying

materials. Usually their collections of medicinal plants are comparatively small, but those which are obtainable are of high quality, and correctly classified. The liberal spirit of some of these stations is now restricted in some instances by government control. Such is the case with the buchu (*Barosma betulina*) of South Africa. To obtain seeds of this form direct from the Transvaal a long and tedious routine of grants, permits, etc., is necessary before they are allowed to be sent out of the country. On the other hand, such places as the Jamaica Public Gardens, Jamaica, the Kew Royal Gardens near London, England, the Royal Botanic Garden of Calcutta, India, the Botanic Garden and Museum of Natural History of Pará, Brazil, the Botanic Garden at Georgetown, British Guiana, and many others in foreign localities are usually willing to exchange or contribute materials for experimental purposes. Of no less distinction and willingness in this respect are the gardens at New York and St. Louis, the Office of Seed and Plant Introduction, and the Bureau of Plant Industry of the United States Department of Agriculture. However, it frequently happens that these excellent and widely separate stations fail to have the materials desired. At present, this condition exists with some unusually desirable species of the genus *Artemisia*.

V

Commercial seedsmen and nurserymen have so far proven the best sources of supply, though they do not always maintain the highest standards of nomenclature. It is encouraging in this respect to note a growing tendency on their part to list more of their materials under the specific technical names. However, great numbers of varietal or trade names are annually introduced through these channels, which cause much confusion and uncertainty. Sooner or later many of these must be reduced to synonymy. Much time and energy is consumed in varietal tests for determining these synonyms, and any movement which will reduce their number must be greatly appreciated. What is most desired in this respect is the retaining of the native and introduced forms under their original names, or at least the recording of varieties in such a manner that the original parents can be traced, and the pedigrees of the supposed new forms accurately obtained.

The catalogues of the most prominent seedsmen and nurserymen from the United States, England, France, Germany, and Japan have been examined for medicinal plants. In such an examination it was necessary to have clearly in mind some means of deciding whether or not a given form should be classed medicinal or non-medicinal. Certain limitations must be exercised in such a distinction, and a conservative rather than a general attitude should be maintained. To follow the inclinations and suggestions of some authors would mean the consideration of an almost unlimited number of plants as possessing medicinal value. Practically, the list should not greatly exceed three hundred in number, and of these there are many included which are of doubtful value. In Bulletin No. 2, California State Board of Forestry, entitled "Pharmacal Plants and Their Culture," there is a context of one hundred and fifty-four pages, eight of which treat of the cultivation of medicinal plants in California. A portion of this small space is given up to such forms as sage, horehound, rosemary, marjoram, and dandelion. The greater bulk of the publication is taken up with a list of "Native and Introduced Medicinal and Poisonous Plants." The inclusion in this list of such forms as sugar maple, box elder, maidenhair fern, common edible mushroom (*Agaricus campestris*), wind flower, columbine, pawpaw, banana, garden beet, clematis, persimmon, California poppy, strawberry, holly, lemon, puffball, sorrel, cinquefoil, yucca and even corn, can hardly be explained. If such plants as the foregoing are to be considered medicinal, the list of three hundred would quickly grow to six hundred or more.

Based upon such a liberal classification, all seedsmen and nurserymen could be said to list medicinal plants regularly, and in large numbers, while as a matter of fact they list but very few. Certainly such a classification is not advisable, from either a practical or a scientific standpoint. The list which has been used as a means of dividing this material into medicinal and non-medicinal contains three hundred and eighty different forms, and includes all those that are commonly used by prominent manufacturers of pharmaceutical preparations.

A LIST OF SEEDSMEN AND NURSERYMEN WHOSE CATALOGUES HAVE BEEN EXAMINED FOR MEDICINAL PLANTS, AND THE NUMBERS OF SUCH FORMS LISTED BY THEM

Name of Firm	Location	Number Medicinal Forms Listed
Bash's Seed Store	Indianapolis, Ind.	25
P. J. Berckmans Co.	Augusta, Ga.	20
A. T. Boddington	New York City	12
Bobbink & Atkins	Rutherford, N. J.	53
Benary, Ernst	Erfurt, Germany	68
Biltmore Nursery	Biltmore, N. C.	45
W. Atlee Burpee & Co.	Philadelphia, Pa.	18
California Nursery Co.	Niles, Cal.	26
Childs, John L.	Floral Park, N. Y.	17
Dreer, Henry A.	Philadelphia, Pa.	47
Elliot Nursery	Pittsburgh, Pa.	33
Ferry, D. M., & Co.	Detroit, Mich.	4
Fottler, Fiske, Rawson Co.	Boston, Mass.	17
Gillett, Edward	Southwick, Mass.	58
Glen St. Mary Nurseries	Glen St. Mary, Fla.	6
Gregory & Son	Marblehead, Mass.	3
Isaac House & Son	Bristol, England	5
Peter Henderson & Co.	New York City	21
Horsford's Nurseries	Charlotte, Vt.	35
Haage & Schmidt	Erfurt, Germany	158
Kelway & Son	Langport, England	10
Medical Nursery	Calcutta, India	50
Livingston Seed Co.	Columbus, Ohio	4
C. C. Morse & Co.	San Francisco, Cal.	8
T. V. Munson & Son	Denison, Texas	4
Monroe Nursery Co.	Monroe, Mich.	16
Henry Mette	Quedlinburg, Germany	58
Oregon Nursery Co.	Salem, Ore.	10
Roumanille Lafayette père & fils	St. Remy de Provence, France	28
John A. Salzer Seed Co.	La Crosse, Wisc.	27
J. M. Thorburn & Co.	New York City	52
Vaughan's Seed Store	Chicago, Ill.	35
Watkins & Simpson	London, England	24
J. D. Webster	Chichester, England	15
Yokohama Nursery Co.	Yokohama, Japan	6

Based upon the number of important species listed, method and accuracy of nomenclature, class of material and general attitude the above list could be reduced to nine as follows: Haag & Schmidt, Benary, Mette, Medical Nursery, Gillett, Thorburn, Biltmore Nursery, Dreer, and Bobbink & Atkins. Materials have been obtained from five of these, and from eight of the others.

The following discussion will consider not only the propagation of this material, but also such related problems as continued growth, productivity, commercial value, hardiness, habitat, and ease of transplanting, cultivating, and harvesting.

The methods of propagation have been those of standard use. Corbett (4) divides these methods into the natural and artificial. The natural methods include reproduction by seeds, spores, rootstocks, stolons, suckers or root sprouts, bulbs, corms, and tubers. The artificial methods consist in reproduction by cuttings, layering, grafting, and budding. Necessary adjuncts to all of these methods are suitable greenhouses, cold frames, hot beds, and open field accommodations.

Propagation from seeds has been practiced wherever possible, and must in nearly all cases precede other methods. Seed propagation, however practical it may be, will not serve all purposes. In breeding experiments and improvement selections, it is often very desirable to multiply individual specimens by other means. Inbreeding for the purpose of obtaining uniform strains is often a long and laborious method, while vegetative reproduction would give the same results in a shorter interval of time. Latent tendencies are more quickly and accurately eliminated, necessary seed production is avoided, as well as the saving of much time in seeding and transplanting.

Open field methods of seeding have been found impracticable and in many cases impossible with many medicinal forms. This condition necessitates a wide deviation from most normal methods of cropping and leads to the necessary development of specialized systems. Little of an agricultural nature has been developed with these forms. Farwell (8) says that belladonna, henbane, digitalis, and aconite can be grown as easily as potatoes. Turner (23) gives directions for growing henbane, which are too general to be of any value. Saunder's (19) statements on the germination of seeds of medicinal plants are general, and include no methods or actual data. Henkel (10) says that digitalis offers no difficulties in cultivation, and advises sowing in the open field or in seed beds. True (22) advocates open field planting of digitalis. Kraemer (13), in his brief notice on seed germination, discourages open field sowing. Open field sowings of henbane, belladonna and digitalis have been

made for three successive years on well-prepared ground, and all have resulted in complete failures. Not enough plants for experimental purposes were obtained by the most careful attention.

Continued failures from open sowing of henbane are reported from England. Thirty years ago Holmes called attention to the difficulties in the cultivation of henbane. He mentioned the uncertainty of the crop in England, and the peculiarities in the germination of the seed. Again (**11**) in 1905 he mentions the uncertainty of the crop. Ransom (**17**) in 1902 claims that it is difficult to obtain a good crop of this drug in Britain. Henkel (**10**) later calls attention to the uncertainty in seed germination. Turner (**23**) in his directions for growing henbane is encouraging in the extreme. In his opinion it is not a difficult crop to handle. Repeated tests in the open field have resulted in failures. Fair germination was obtained in one instance, but the seedlings could not compete with common weeds until large enough for cultivation. Seed tests carried on under glass indicate that germination is of high percentage, uniform and fairly regular for seeds from different sources.

With some of the older drugs in cultivation, propagation and cultural systems have been highly developed. Examples of this may be found in the excellent notes of Weddell (**24**) on the nurseries, cultivation, harvesting and curing of coca, of Lumsdaine (**15**) on the cultivation of nutmegs and cloves in Bencoolen, of Eatwell (**7**) on the methods of cultivation, collecting, and curing of opium, and the influence of soil and climate upon the yield and quality of the product, and of DeVry (**6**) on cinchona.

There are few authentic data or directions, however, upon the propagation and cultivation of the more important forms which are adapted to this country. This list might well include such forms as belladonna, henbane, stramonium, digitalis, arnica, larkspur, valerian, santonica, veratrum, hellebore and others. It is evident that methods would have to be developed to suit the conditions of soil and climate, and at the same time be varied to meet the purposes of the work. That is, commercial production might be possible under a system which would be worthless for experiments on plant breeding and improvement.

In the following discussions the questions of propagation have

been taken up in conjunction with other problems, and have only been developed as progress might demand. The work has been done for the purpose of determining the practicability of growing certain drug plants upon a commercial scale, and the possibility of improving them through an application of the methods of plant breeding. All seed tests have been of a practical nature, and but little of the great mass of material upon the effects of various reagents and influences upon germination has been used. This material so far seems to have resulted in no new general laws applicable to commercial growers. Experiments upon the effects of light and darkness (Heinricher, 9) upon seed germination, temperature (Reynolds, 18) in relation to germination, treatment with warm water (Jensen, 12), sterilization of soil (Stone & Smith, 21), copper sulphate treatment (Bréal & Giustiniani, 2), electrical effects (Monahan, 16), soaking in chlorine water (Spatschil, 20), soil temperature (Brown, 3), action of ether and chloroform (Becquerel, 1) and delayed germination (Crocker, 5), have resulted in many data but few generalizations. Specific gravity tests, sterilized soils and the sulphuric acid treatment (Love & Leighty, 14), have been used successfully and might be recommended for practical purposes. The forms under consideration and the results so far obtained are as follows:

DIGITALIS

More or less uncertainty exists as to the exact botanical source of this drug. The comparative medicinal value of the leaves from wild and cultivated forms, and the disputed methods of collection, curing and packing are unsettled questions of considerable importance. The comparative value of the many species and horticultural varieties, their ease of culture, relative yield of crude drug, their flowering periods, hardiness and duration of growth are additional problems which must be investigated before the genus can be made to yield its best to the manufacture of medicine.

Open field sowing was tried several times during two successive years. These tests were carried out both under practical field conditions and in ideally prepared seed beds. The results were complete failures and open seed sowing under field conditions

cannot be recommended. After this preliminary work, the open field methods were abandoned for the more reliable greenhouse methods.

Seeds of twenty-seven varieties were obtained for experimental plantings. These were germinated (see Table I) in seed pans under glass, and transplanted to flats as soon as the second leaves were visible. These flats were retained in a cool greenhouse of 50 degrees night temperature, and 60 degrees day temperature, until March 1, when they were transferred to cold frames. The sashes of these frames were of double glass construction, and required little attention until the latter part of April. Then the sashes had to be removed during the day to prevent burning of the foliage, and to thoroughly harden off the young seedlings before transplanting to the field.

Transplanting to the open field was done mostly by inexperienced labor, and during dry weather accompanied by strong winds. The inexperienced labor was used as a means of determining the transplanting qualities of these forms, and the unfavorable weather only rendered this test more severe. After transplanting, the young plants were watered twice on consecutive days, and then left to the influence of natural conditions. Cultivation was commenced early, and repeated frequently throughout the growing season. The soil was a poor, stiff, clay loam, but all forms of the digitalis made excellent growth, as is evidenced by the amount of dry leaf produced by some average individual plants. Some of these yielded as follows:

Digitalis maculata Iveryana, a strong and robust form, 392 grams, *Digitalis gloxinioides* 170 grams, Digitalis Ivery's spotted 209 grams, and *Digitalis alba* 1,721 grams. In obtaining the comparative yield (see Table I) of all the varieties, ten average plants were selected, and all the leaves collected from them, and thoroughly air dried. The figures representing comparative yield of *Digitalis alba*, *D. purpurea* and *D. canariensis*, Watkins; *D. sibirica*, *D. lanata*, and *D. ambigua*, Horsford; and *D. gloxiniaeflora rosea*, Dreer, are all low on account of early collection. Those for the other forms, however, are accurate enough for all practical purposes. The comparative toxicity as given in the table is based upon figures obtained by the one hour frog heart method for testing *Digitalis*

and its preparations. The value "one" represents the greatest toxicity, while the numerical increase indicates a proportional decrease in toxicity. Thus the weakest sample tested (*Digitalis gloxiniaeflora alba*) has a toxicity of 6.3.

Another object of the *Digitalis* study was to test the effects of hybridization upon medicinal value. For this work, it was very desirable to bring the various species and varieties into flower as soon as possible. Early seed sowing augmented by a rather rapid growth in the greenhouse and by a slow hardy growth in the cold frames, as well as by a late and unusually favorable season, resulted in a number of flowering plants from several species and varieties (see Table II). For the purpose of obtaining early flowering plants upon which to begin the work of inbreeding and hybridization, a number of one year old plants were purchased from A. T. Boddington. These began flowering early, and furnished material throughout the season. Various combinations were tried, a number of which were successful, and seedlings are already being propagated in an effort to bring them into flower the first year. Thus any breeding operations can be annually continued or discontinued as the results may indicate, whereas these forms under the usual conditions of propagation would require two years to reach maturity.

It has also been noted that a small number of annual forms have appeared in the late plantings of several species and varieties, and especially where large numbers of plants were used. In all cases these have been inbred. The resulting progeny of these inbred annuals will be closely observed for the reappearance of annual forms.

Root division and propagation of lateral buds have both been tried with several varieties of *Digitalis* (see Table III). It was hoped that clonal varieties could be obtained in this manner. Uniformity of individuals and their behavior to varied soil and climatic conditions could then be studied with greater accuracy. Lateral buds, with and without roots, were carefully removed. Those removed during summer, fall and winter were extremely hard to start, whether they bore roots or not. Sand proved to be the best material for this purpose. However those made in early spring from plants left in the open have yielded a large percentage of

plants. Side cuttings, with and without roots, made February 21, 1913, had rooted in sand in the greenhouse March 20, 1913.

BELLADONNA

The propagation of belladonna was first attempted through open field sowing. Successive trials under varied field conditions with seed from several different sources resulted in complete failures. Fall sowing of imported seed upon a carefully prepared seed bed gave the following result. Seed planted September 3, 1912, fair germination October 21, 1912. Seed collected from growing plants August 15, 1912, planted September 3, 1912, fair germination October 21, 1912.

Greenhouse conditions were then tried, which were practically the same as those for digitalis, except that the seed pans used were more carefully protected from alternate degrees of moisture and dryness. See Table IV for germination data, and Tables V and VI for the influence of certain seed treatments upon germination.

The belladonna seedlings transplant with considerable ease and with practically no loss. Damping off is not so frequent as with digitalis and henbane. Sterilized soil and careful watering greatly reduce this trouble in all cases. The belladonna seedlings were retained in the greenhouse in flats until well established, and were then transferred to the cold frames. This was done on some occasions as early as March 19. Observations at this time showed a temperature of 46 degrees inside the frames, with the outside temperature below freezing. Outside night temperatures of 18 degrees caused no injury to the seedlings under the unprotected double glass sash. Seedlings transplanted directly into the frames in stiff clay soil made slower growth than those in the better soil of the flats, but produced hardier and more stalky plants, which transplanted to the open with much greater ease and certainty. They also made better subsequent growth than those in the flats. They required much less attention while in the frames, having to be watered only occasionally, while those in the flats dried out rapidly as the season advanced, and demanded considerable attention. Seedlings retained in the greenhouse in flats until May 10 were tender and succulent and wilted badly when transferred to the open field. From thirty to forty per cent. were lost

during this second transplanting, while with those from the cold frames this loss was scarcely appreciable.

The successful propagation of the belladonna plant was only a necessary preliminary procedure to other more important problems. It was desired to observe this form under cultivation, to study its commercial production and the possibilities of developing a strain which would produce a uniformly higher yield of alkaloids than the ordinary commercial drug.

The first of these problems was accomplished through seed propagation. No difficulty was experienced in obtaining an abundance of plants after indoor methods of propagation were adopted. Large luxuriant plants were obtained from seed sown March 8, 1912, and were flowering by July 12. It is interesting to note here that the plants which had been transplanted directly from the seed pans to the poor soil in the cold frames were the first plants to commence flowering. The plants at this time (July 12) were from two to three feet tall, and much branched. Ransom (17) says that belladonna grown in England from seed sown in early spring produces little if any herb worth cutting the first year.

It is now believed that two profitable harvests can be obtained during one growing season, from plantings made January 1st of the same year. The belladonna plant is an herbaceous perennial, but on account of its susceptibility to winter killing in this climate, it may have to be grown as an annual. 1724 plants were left in the open without protection as a test for hardiness and as a means of obtaining individual plants of unusual hardiness from which to develop a strain more adapted to this climate. September 24 the entire herbaceous portion was removed from 1414 of these plants, the remaining 310 being left undisturbed. Twelve clumps of roots were lifted November 7, 1912, and placed in the cold frames with no protection except the double glass sash. The sash was put on at this time, and left closed until March 31, 1913, when the plants were first observed. At this time they were all bearing vigorous sprouts. Those left in the open were showing no growth on this date. These were again observed May 1, and the following conditions noted:

Number of plants, from which herbaceous portion had been removed, showing growth, 44.

Number of plants, which had been left undisturbed, showing growth, 307.

The second object of the belladonna investigation, viz., the attempt to produce a strain which would yield a uniformly higher percentage of alkaloids than the commercial drug, involves another method of propagation. In this case, individual plants must be examined for their property of yielding certain percentages of alkaloids. It is desirable to propagate promising individuals in such a manner that the high yielding character will be uniformly transmitted to the offsprings. As yet it is not known how such a character behaves. Alkaloids are not essential products of metabolism, and the inheritance of the property of producing a large percentage of such products is indeed questionable.

To investigate this point, both seed and vegetative propagation of pure strains must be practiced. The behavior of the character in these pure strains and their progeny will throw much light on the possibility of developing, propagating, and maintaining high yielding varieties through the practice of breeding.

If the property of an individual plant to produce a definite amount of alkaloids when grown under uniform conditions, behaves in the same manner as many external characters, the propagation of pure bred strains by the vegetative method should yield uniformly according to selection.

To test this possibility, it was necessary to follow the methods of the florist in the propagation of cuttings in sand. This was done both in the greenhouse and in the open under cheese cloth shade. In the greenhouse the open sand bed was tried as well as the glass-covered bed recommended by Bailey. The open bed was also tried, with the cheese cloth shade. The best results in the greenhouse were obtained with the open bed under the influence of a mild bottom heat, and very careful watering. Sterile sand had to be used to prevent a total loss of the cuttings from the attack of a very small white worm, which fed on the lower ends of the cuttings, and prevented callousing until decay would commence. The best outdoor results were obtained from the use of the cold frames protected with cheese-cloth shades. Top cuttings made from the more mature wood of the open grown plants strike root more readily than those from the tender succulent wood of plants grown in the greenhouse.

Table III gives results obtained by the vegetative method of propagation for belladonna and other miscellaneous forms. Open field seeding has been found practical for such forms as stramonium (*Datura Stramonium*), cannabis indica (*Cannabis sativa*), larkspur (*Delphinium Consolida*), and lappa (*Arctium Lappa*). This list can probably be greatly enlarged as other forms are tested.

Various species and varieties of the genus *Datura* are being investigated in the same manner as belladonna and digitalis. Fifty individual plant assays have been made from plantings of *Datura Stramonium* and *Datura Tatula*. These indicate that the application of plant breeding methods to the improvement of medicinal plants may be successful, and extremely practicable. Averages of 50 per cent. and 60 per cent. have been obtained from the progeny of selected parent plants of *Datura Stramonium* and of 49 per cent. and 62 per cent. from *Datura Tatula* as compared with averages of 28 per cent. and 35 per cent. obtained respectively from wild plants of these two species. Individual plants have been found which assay as high as 65 per cent. for the *D. Stramonium* and 77 per cent. for *D. Tatula*. Such individuals are used for propagating purposes. Again, as in the case of belladonna, it is a question of inheritance that must determine the method of propagation or the advisability of attempting to perpetuate these high yielding individuals for commercial purposes.

In the foregoing, propagation has only been considered as a necessary preliminary procedure to other more comprehensive problems. A sufficient number of methods for propagating various classes of plants has been developed to suit the present need of medicinal plant growers. These have been largely the result of certain demands upon well-established horticultural forms, and their extended use is only a matter of application.

Their application herein described has furthered investigations not otherwise possible. The results obtained from their application, the continuation of other related problems, and the objects in view, have all been stated. The related problems such as commercial production, the testing of different species and varieties, and their improvement by breeding and selection, have an unquestionable economic value, the solution of which will lend

TABLE I

FIELD RECORD

Species or Varieties	Source	Date Planted	Date Germinated	Per Cent. Germination	Date First Transplanting	Number Plants Used	Date Second Transplanting	Number Transplanted to Field	Number at End of Season, 10-31-12	Samples Collected	Per Cent. Loss in Drying	Comparative Toxicity	Comparative Yield of Dry Drug
		1912	1912		1912		1912			1912			gm.
Digitalis purpurea rosea	Boddington	2-6	2-15	90	3-13	440	5-20	396	358	9-15	82	1.3	1,845
Digitalis purpurea rubra	Boddington	2-6	2-15	70	3-18	330	5-21	264	226	9-15	82	1.5	1,656
Digitalis lanata	Boddington	2-6	2-19	60	3-12	209	5-25	88	87	9-19	76	1.0	1,008
Digitalis Ivery's spotted	Ferry	2-29	3-11	60	3-29	330	5-24	264	244	10-11	86	1.8	2,090
Digitalis mixed	Salzer	3-7	3-18	90	4-2	330	5-25	176	153	10-18	82	2.5	1,755
Digitalis sp.	Yokohama	3-5	3-18	80	4-5	330	5-23	264	239	10-18	81	3.0	1,495
Digitalis lutea	Benary	3-22	4-1	60	4-11	330	5-22	264	256	11-1	70	2.1	554
Digitalis macranthus	Benary	3-22	4-1	70	4-11	330	5-23	264	231	11-1	67	2.6	430
Digitalis Buxbaumi	Benary	3-22	4-1	70	4-10	330	5-23	264	253	11-1	74	1.6	994
Digitalis purpurea maculata superba	Benary	3-22	4-1	60	4-11	330	5-25	176	168	11-1	77	1.6	1,360
Digitalis purpurea	Oregon	2-19	3-1	60	4-1	1390	5-10	1300	952	7-14	76	3.0	425
		1911	1911										
Digitalis alba	Watkins	11-22	12-1	90	1-30	345	5-20	264	193	7-25	78	2.3	391
Digitalis purpurea	Watkins		12-1	90	1-30	351	5-25	88	83	7-25	80	3.0	312
		1912	1912										
Digitalis canariensis	Watkins	1-4	1-15	70	2-15	440	5-21	264	244	8-15	47	1.6	266
Digitalis monstrosa	Watkins	2-7	2-15	80	3-15	440	5-20	396	349	9-15	84	2.6	1,150
Digitalis sibirica	Horsford	2-8	2-19	80	3-11	220	5-21	396	380	7-28	72	1.8	149
		1911	1911										
Digitalis lanata	Horsford	12-20	12-28	40	2-6	99	5-25	176	173	7-28	76	1.3	219
Digitalis ambigua	Horsford	12-21	12-29	40	2-14	200	5-21	264	243	7-29	66	1.8	173
		1912	1912										
Digitalis gloxinioides	Horsford	2-7	2-16	80	3-4	450	5-20	616	552	9-16	82	1.5	1,850
Digitalis gloxiniaeflora rosea	Dreer	1-8	1-19	80	2-15	100	5-20	264	213	8-19	74	2.0	664
Digitalis monstrosa	Dreer	2-7	2-15	90	3-1	511	5-20	428	394	9-15	82	1.8	1,645
Digitalis grandiflora	Dreer	2-7	2-19	60	3-27	330	5-24	264	220	9-19	68	3.0	351
Digitalis maculata Iveryana	Boddington	1-17	1-25	80	2-13	333	5-21	264	228	8-35	84	1.6	1,050

TABLE I (*Continued*)

FIELD RECORD

Species or Varieties	Source	Date Planted	Date Germinated	Per Cent. Germinated	Date First Transplanting	Number Plants Used	Date Seeond Transplanting	Number Transplanted to Field	Number at End of Season, 10-31-12	Samples Collected	Per Cent. Loss in Drying	Comparative Toxicity	Comparative Yield of Dry Drug
Digitalis gloxiniaeflora purpurea	Boddington	1-30	2-10	70	3-7	440	5-20	352	318	9-10	84	1.5	1,815
Digitalis gloxiniaeflora lutea	Boddington	1-30	2-13	60	3-6	440	5-22	264	262	9-13	74	1.6	882
Digitalis gloxiniaeflora lilicina	Boddington	2-6	2-14	80	3-8	440	5-22	308	272	9-14	80	1.6	1,715
Digitalis gloxiniaeflora alba	Boddington	2-6	2-15	80	3-16	330	5-24	308	224	9-15	82	6.3	1,475
Digitalis purpurea alba	Boddington	2-6	2-15	80	3-12	440	5-20	396	334	9-15	84	1.6	1,855

TABLE II

DATES OF FLOWERING AND NUMBER OF PLANTS IN FLOWER

Variety	Source	Date Planted	Jul. 15	Jul. 20	Jul. 25	Jul. 30	Aug. 10	Aug. 10	Sep. 1	Sep. 20	Oct. 15	Used
		1911										
Digitalis lanata	Horsford	12-20						1		2	2	97
Digitalis ambigua	Horsford	12-21	1	17	35	49	54	87	151	217	220	233
		1912										
Digitalis canariensis	Watkins	1-4									2	224
Digitalis gloxiniaeflora lutea	Boddington	1-30		1	1			3	11	68	95	386
Digitalis purpurea rosea	Boddington	2-6						1				358
Digitalis purpurea alba	Boddington	2-6					1					334
Digitalis gloxinioides	Horsford	2-7					4		5	9	10	383
Digitalis monstrosa	Watkins	2-7					1	2			2	349
Digitalis grandiflora	Dreer	2-7		1	2		5	32	113	189	239	240
Digitalis sibirica	Horsford	2-8								6	20	294
Digitalis Iverys spotted	Ferry	2-29									1	344
Digitalis sp.	Yokohama	3-5									5	239
Digitalis macranthus	Benary	3-22		2	3		16	81	161	217	222	231
Digitalis lutea	Benary	3-22								1	3	256
Digitalis Buxbaumi	Benary	3-22							1	7	25	319

TABLE III

PROPAGATION BY CUTTINGS

Name	Source	Number Started	Date Started	Number Rooted	Date Rooted	Method
			1912		1912	
Belladonna	Field plants	26	7–31	0		Greenhouse, open sand bed.
Belladonna	Field plants	17	8–3	1	8–19	Greenhouse, open sand bed.
Belladonna	Field plants	24	8–1	0		Greenhouse, open sand bed.
Belladonna	Greenhouse plants	76	5–14	73	6–6	Greenhouse, bottom heat.
Belladonna	Greenhouse plants	25	8–1	0		Greenhouse, bottom heat.
Belladonna	Greenhouse plants	35	8–14	0		Greenhouse, bottom heat.
Coleus control	Greenhouse plants	6	8–14	4	8–26	Greenhouse, bottom heat.
Coleus control	Greenhouse plants	19	8–22	0		Greenhouse, bottom heat.
Coleus control	Greenhouse plants	28	8–22	0		Greenhouse, bottom heat.
Coleus control	Greenhouse plants	5	1–30	0		Greenhouse, bottom heat.
Coleus control	Greenhouse plants	121	1–22	0		Greenhouse, glass covered bed.
Coleus control	Greenhouse plants	49	1–29	0		Greenhouse, open sand bed.
Coleus control	Greenhouse plants	42	1–29	0		Greenhouse, open sand bed.
Coleus control	Field plants	220	9–4	107		Cold frames, cheese cloth shades.
Coleus control	Field plants	180	9–6	101		Cold frames, cheese cloth shades.
Digitalis canariensis	Field plants	50	6–10	19	6–29	Greenhouse, open sand bed.
Digitalis canariensis	Field plants	40	7–13	0		Greenhouse, cheese cloth shade.
Digitalis canariensis	Field plants	21	7–31	0		Greenhouse, open sand bed.
Cytisus scoparius	Greenhouse plants	20	5–8	12	6–29	Greenhouse, open sand bed.
Cytisus scoparius	Greenhouse plants	55	6–29	30	8–30	Greenhouse, open sand bed.
Nasturtium control	Greenhouse plants	7	6–29	6	7–8	Greenhouse, open sand bed.
Cereus grandiflorus	Crude drug	36	6–5	18	6–29	Greenhouse, open sand bed.
Marshmallow	Field plants	11	7–31	11	8–19	Greenhouse, open sand bed.
Solanum Dulcamara	Field plants	7	8–5	4	8–30	Greenhouse, open sand bed.
Vanilla	Greenhouse plants	21	6–20	14	8–20	Greenhouse, open sand bed.
Digitalis	Field plants	6	2–21	4	3–18	In sand under bell glass.

TABLE IV

SEED GERMINATION

Name	Source	Date Planted	Date Germinated	Germination	Conditions
Atropa Belladonna	Greenhouse	12-21-11	1-24-12	Good	Greenhouse
Atropa Belladonna	Comm. sample	12-11-11	1-26-12	Uneven—fair	Greenhouse
Atropa Belladonna	Greenhouse	1- 4-12	2- 9-12	Good	Greenhouse
Atropa Belladonna	Comm. Lot.	2- 9-12	3- 1-12	Fair	Greenhouse
Atropa Belladonna	Comm. Lot	2-19-12	3- 8-12	Poor	Greenhouse
Atropa Belladonna	Dept. Agri.	1-10-12	2-20-12	Very good	Greenhouse
Atropa Belladonna	Dept. Agri.	2-20-12	3-10-12	Fair	Greenhouse
Atropa Belladonna	Aug. & Geo. Fischer	2-26-12	3-21-12	Good	Greenhouse
Atropa Belladonna	Cult. plants	12-24-12	12-20-12	Good	Greenhouse
Atropa Belladonna	Haag & Schmidt	2-22-13	3-23-13	Poor	Greenhouse
Atropa Belladonna	Select plant	2-25-13	3-19-13	Poor	Greenhouse
Atropa Belladonna	Select plant	2-25-13	3-19-13	Poor	Greenhouse
Atropa Belladonna	Select plant	2-25-13	3-19-13	Poor	Greenhouse
Atropa Belladonna	Select plant	2-25-13	3-27-13	Poor	Greenhouse
Atropa Belladonna	Select plant	2-25-13	3-27-13	Poor	Greenhouse
Atropa Belladonna	Aug. & Geo. Fischer	9- 3-13	10-21-12	Fair	Open field
Atropa Belladonna	Cultivated plants	9- 3-12	10-21-12	Fair	Open field
Nicandra physaloides	Haag & Schmidt	2-22-12	3- 7-12	Good	Greenhouse
Hyoscyamus niger	Benary	2-22-12			
Hyoscyamus niger	Benary	3-22-12	4- 3-12	Fair	Greenhouse
Hyoscyamus niger	Aug. & Geo. Fischer	3-22-12			
Hyoscyamus niger	Aug. & Geo. Fischer	2-12-12	2-23-12	Good	Greenhouse
Hyoscyamus niger	Aug. & Geo. Fischer	2- 7-12	2-14-12	Good	Greenhouse
Hyoscyamus niger	Haag & Schmidt	2-25-12		No result	Greenhouse
Hyoscyamus niger	Haag & Schmidt	2- 7-12		No result	Greenhouse
Hyoscyamus niger	Yokohama, Japan	2-25-12	3-20-12	Fair	Greenhouse
Hyoscyamus niger	Yokohama, Japan	3-14-13	4- 3-13	Poor	
Hyoscyamus sp.	Watkins & Simpson	5- 5-13		No result	Greenhouse
Hyoscyamus annual	Cultivated plant	5- 3-13	3-27-13	Good	Greenhouse
Hyoscyamus orientalis	Haag & Schmidt	2-10-13	2-27-13	Poor	Greenhouse

TABLE IV (*Continued*)

SEED GERMINATION

Name	Source	Date Planted	Date Germinated	Germination	Conditions
Hyoscyamus muticus	Wheeler & Son	2-24-13	3- 8-13	Fair	Greenhouse
Hyoscyamus muticus	Aug. & Geo. Fischer	3-20-12		No result	Greenhouse
Hyoscyamus sp.	Vaughn	4-15-10		No result	Greenhouse
Glycyrrhiza glabra	Haag & Schmidt	4-30-12	5- 9-12	Very poor	Greenhouse
Glycyrrhiza glabra	Haag & Schmidt	12-24-12	1- 2-13	Poor	Greenhouse
Bryonia alba	Haag & Schmidt	12-24-12		No result	Greenhouse
Bryonia dioica	Haag & Schmidt	12-24-12		No result	Greenhouse
Cinchona officinalis	Haag & Schmidt	2- 8-13	3-28-13	Poor	Leaf mould
Cinchona Calisaya	Haag & Schmidt	2- 8-13		No result	Leaf mould
Cinchona succirubra	Haag & Schmidt	2- 8-13		No result	Leaf mould
Erythroxylum Coca	Haag & Schmidt	2- 8-13		No result	Leaf mould
Veratrum album	Haag & Schmidt	2- 8-13		No result	Leaf mould
Veratrum viride	Haag & Schmidt	2- 8-13		No result	Leaf mould
Veratrum nigrum	Haag & Schmidt	2- 8-13		No result	Leaf mould
Colchicum autumnale	Haag & Schmidt	2- 8-13		No result	Greenhouse
Gentiana lutea	Haag & Schmidt	2- 8-13		No result	Greenhouse
Laurus Cinnamomum	Haag & Schmidt	2- 8-13		No result	
Santalum album	Haag & Schmidt	2-10-13		No result	
Strychnos Nux-vomica	Haag & Schmidt	2-10-13		No result	
Convolvulus Scammonia	Haag & Schmidt	2-10-13	2-18-13	Poor	
Citrullus Colocynthis	Haag & Schmidt	2-10-13	3-28-13	Poor	
Piper nigrum	Haag & Schmidt	2-10-13		No result	
Quillaja Saponaria	Haag & Schmidt	2-10-13		No result	
Scilla maritima	Haag & Schmidt	2-10-13		No result	
Aloe ferox	Haag & Schmidt	2-10-13		No result	
Archangelica officinalis	Haag & Schmidt	3-14-13		No result	Greenhouse
Anthemis nobilis	Haag & Schmidt	3-14-13	3-19-13	Good	Greenhouse
Arnica montana	Haag & Schmidt	3-14-13	3-21-13	Fair	Greenhouse
Levisticum officinale	Haag & Schmidt	3-14-13		No result	Greenhouse
Pyrethrum cinerarifolium	Haag & Schmidt	3-14-13	3-24-13	Good	Greenhouse
Carthamus tinctorius	Haag & Schmidt	3-14-13	3-18-13	Good	Greenhouse
Foeniculum vulgare	Haag & Schmidt	3-14-13	3-24-13	Good	Greenhouse

TABLE IV (*Continued*)

SEED GERMINATION

Name	Source	Date Planted	Date Germinated	Germination	Conditions
Elettaria Cardamomum	Comm. Sample	12–27–12		No result	Greenhouse
Delphinium Staphisagria	Comm. Sample	12–27–12	1–20–13	Poor	Greenhouse
Grindelia robusta	U. S. Dept. Agr.	2–11–13	2–15–13	Good	Greenhouse
Insect flowers	Comm. Lot	2–11–13		No result	Greenhouse
Strophanthus sp.	Comm. Lot	2–19–13		No result	Greenhouse
Strophanthus sp.	Comm. Lot	2–19–13	3– 5–13	Poor	Greenhouse
Althaea officinalis	U. S. Dept. Agr.	2–22–13	3– 5–13	Good	Greenhouse
Berberis Aquifolium	Commercial	3–10–13	4– 3–13	Fair	Greenhouse
Conium sp.	Comm. Lot	5– 5–13	3–20–13	Good	Greenhouse
Theobroma Cacao	Jamaica	3–14–13		No result	Greenhouse
Valeriana officinalis	Dreer	3–27–13		Good	Greenhouse
Apium Petroselinum	Comm. Lot	4– 4–13	4–17–13	Good	Greenhouse
Amomum Melegueta	Comm. Lot	4– 4–13		No result	Greenhouse
Apium graveolens	Comm. Lot	4– 4–13	4–16–13	Good	Greenhouse
Coriandrum sativum	Comm. Lot	4– 4–13	4–18–13	Good	Greenhouse
Chenopodium ambrosioides	Comm. Lot	4– 4–13	4–21–13	Good	Greenhouse
Carum Carvi	Comm. Lot	4– 4–13	4–17–13	Fair	Greenhouse
Delphinium Staphisagria	Comm. Lot	4– 4–13		No result	Greenhouse
Lobelia inflata	Comm. Lot	4– 4–13		No result	Greenhouse
Foeniculum vulgare	Comm. Lot	4– 4–13		No result	Greenhouse
Foeniculum vulgare	Comm. Lot	4– 4–13		No result	Greenhouse
Schoenocaulon officinale	Comm. Lot	4– 4–13		No result	Greenhouse
Pimpinella Anisum	Comm. Lot	4– 4–13		No result	Greenhouse
Citrullus Colocynthis	Comm. Lot	5– 1–12		No result	Greenhouse
Aristolochia Serpentaria	Comm. Lot	5– 2–12		No result	Greenhouse
Schoenocaulon officinale	Comm. Lot	5– 8–12	7– 8–12	Poor	Greenhouse
Amomum Melegueta	Comm. Lot	5– 8–12	5–20–12	Fair	Greenhouse
Strophanthus sp.	Comm. Lot	5– 8–12			Greenhouse
Datura ferox	Haag & Schmidt	5–28–12	6– 4–12	Good	Greenhouse
Strophanthus Kombe	Comm. Sample	6–18–12			Greenhouse
Strophanthus hispidus	Comm. Sample	6–18–12			Greenhouse
Citrullus Colocynthis	Comm. Sample	6–18–12	7– 8–12	Poor	Greenhouse

TABLE V

EFFECT OF SEED AND SOIL TREATMENT ON GERMINATION

Name	Date Planted	Date Germinated	Germination	Treatment
Belladonna.....	2—6—12	3— 2—12	Good	Water
Belladonna.....	2—5—12	3— 5—12	Good	Warm water
Belladonna.....	2—7—12	2—26—12	Very good	Warm water
Belladonna.....	2—7—12	2—26—12	Very good	Warm water
Belladonna.....	2—5—12	3—25—12	Good	Warm water
Belladonna.....	2—6—12	3— 2—12	Poor	Untreated

TABLE VI

CONCENTRATED SULPHURIC ACID TREATMENT FOR BELLADONNA

	Planted	Germ.	No. Seedling	Date	No. Seedling	Date	No. Seedling	Date	No. Seedling	Date	No. Seedling
	1913	1913		1913		1913		1913		1813	
Untreated.....	2-14			3-13	3	3-19	3	3-28	14	4-8	24
Treated 5 mi.....	2-14	3-5	2	3-13	4	3-19	10	3-28	27	4-8	36
Treated 10 mi....	2-14	3-5	3	3-13	11	3-19	46	3-28	125	4-8	138
Treated 15 mi....	2-14			3-13	3	3-19	15	3-28	32	4-8	31

much to the demands for better and more precise medicinal products.

INDIANAPOLIS, INDIANA.

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INDEX TO AMERICAN BOTANICAL LITERATURE

1910–1914

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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